Elegant Experiments

*Practical Science made **easy** for teachers and students.*
Chemistry, Physics, Biology and Geology for junior and senior school science.

Volume I

By Greg Reid

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USING THIS BOOK

These books are intended as a user friendly resource for teachers to encourage "hands on science". The experiments can easily be incorporated when developing new programs, responding to a new syllabus or to enrich current programs.

While handing photocopy experiments to students may seem too easy, there are advantages beyond time saved to teachers. I have found that writing up lengthy procedures merely fragments student topic notes and the time consumed in writing directions often means the activity is rushed with conclusions poorly addressed.

TRAINING

Students are often unused to following written practical instructions. It is wise to start with a simple experiment, read and demonstrate each procedure step, carefully explain what you expect for records of results and conclusion, then read out any warnings in the Risk Assessment on your Teacher Copy. Warnings do not appear on Student Copies since some parents might be unduly alarmed.

Make sure you collect and mark the completed Student Copies in the first instance and randomly thereafter. You will find the students adapt rapidly to this approach to practical work. You will be able to allow accelerated progression, different work stations and cooperative learning approaches in the laboratory.

EXPERIMENTS

The experiments are listed alphabetically by name to make them easy to find, however I draw your attention to the INDEX BY TOPIC at the end of the book. The topic index covers all volumes and lists experiment names under topics to which they are related. The purpose of the topic index is so you can quickly find experiments relating to a particular area of study. Rather than complicate the index by duplicating junior and senior topics, common topics appear only once with both junior and senior experiments appearing below.

EQUIPMENT

I have tried to include <u>all</u> the equipment needed in each experiment. Concentrations are given in percentages so you are not constantly stopping to calculate molarities.

The following guides might help:

1/ The equipment list is based on items required by one group.

2/ Any chemical listed with a concentration is a stock solution that must be prepared. In the case of concentrated acids with density and strength corrections the following applies;

Hydrochloric acid, 370g/litre	1Molar = 10%
Sulfuric Acid, 98%, 1.84g/ml density,	1Molar = 5.4%
Nitric Acid, 70%, 1.42g/ml density,	1Molar = 6.3%
Phosphoric acid, 85%, 1.69g/ml density	1Molar = 6.8%
Ethanoic Acid (Glacial Acetic) 99%,	1Molar = 6.6%

3/ Any chemicals without a concentration means simply a class supply.

4/ Please read the risk assessment for your own protection during preparation and DISPOSAL.

5/ I recommend that you photocopy the Teacher Copies and place them in plastic sleeves in a ring folder.

Please feel free to write to me with any suggested improvements and any new experiments would be most welcome.

RISK ASSESSMENT

Every experiment has certain risks, not just from chemicals and equipment but from the unpredictable nature of students. In my years of teaching I have seen some remarkably stupid things such as a student attempting to "snort" citric acid or another trying a sucking contest wth a vacuum cleaner. With this in mind my classification of risk is based on chemical toxicity and exposure (following the new lists), except where the "student factor" seems a greater hazard. Of course professional judgment is needed. Some junior classes can be trusted with delicate equipment while others cannot be trusted with a pair of scissors. However as a general guide:

Low Hazard - Junior Classes

Mild Hazard - Junior classes with close supervision.

Moderate Hazard - Senior classes

HAZARDOUS - Teacher demonstration only.

Remember , familiarity often breeds contempt. Chemicals that are used often may be more toxic than you realise. For example cobalt chloride is a suspected carcinogen with an LD50 of 80mg/kg and and has been deleted from junior experiments in these books. By comparison, copper sulfate, a very commonly used laboratory chemical, has an LD50 of only 300mg/kg. Phenol has the same toxicity yet I am sure you are much more cautious of phenol than you are of copper sulfate. By contrast, lead nitrate is not overly toxic but is dangerous due to its accumulation from repeated small exposures.

PRACTICAL ASSESSMENT SUGGESTIONS

1/ A list of controlled experiments appears in the topic index. Ask your students to identify the appropriate control in each of these experiments.

2/ Collect student work sheets at random and apply a standard marking scale eg. records (4marks), observations (2marks), results (2marks), and conclusion (2marks). This should make the students take practical work seriously, encouraging participation, accurate records and a deductive conclusion (too often neglected).

3/ Record anecdotal marks as the students perform the experiment, focusing on equipment recognition, reading instructions and complete notes.

STUDENT:________________

1 A Hairs Width

Aim: To measure the thickness of a human hair with great precision.

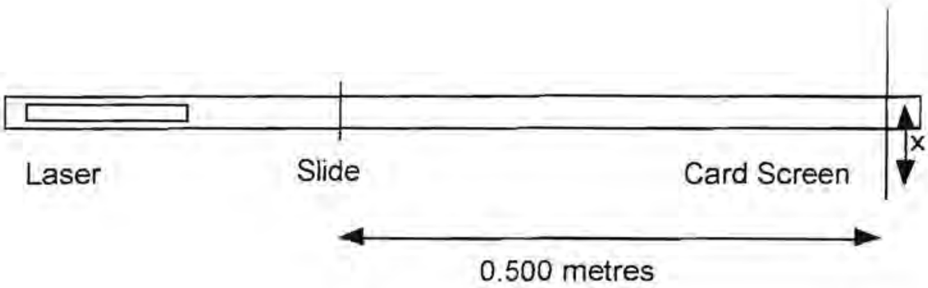
Equipment

Laser Pointer
Glass Slide
sticky tape
scissors
White card, 40cm by 5cm

Procedure

Place a human hair from a volunteer onto a glass slide perpendicular to the long axis of the slide.
Fix the hair in place with sticky tape on the edges.
Place the slide 50cm from, and parallel to the white card.
The hair should be vertical.
Place the laser 10cm in front of, and perpendicular to the glass slide.
Mark the positions of the central and other maxima projected on the card.
Hint: A "Light Bench" is ideal for this experiment.

$n\lambda = dx / L$, $L = 0.500$m, λ = wavelength of laser ,
x = distance from central maximum to first interference maximum. $n = 1$
d = width of the hair
Hint : It is important that the laser is perpendicular to the slide and the white card.



Results: ____

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Conclusion: ____

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TEACHER COPY

1

A Hairs Width

Topics: Light Wave Prop Light

Aim: To measure the thickness of a human hair with great precision.

Equipment

Laser Pointer
Glass Slide
sticky tape
scissors
White card, 40cm by 5cm

Procedure

Place a human hair from a volunteer onto a glass slide perpendicular to the long axis of the slide.
Fix the hair in place with sticky tape on the edges.
Place the slide 50cm from, and parallel to the white card.
The hair should be vertical.
Place the laser 10cm in front of, and perpendicular to the glass slide.
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Hint: A "Light Bench" is ideal for this experiment.

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x = distance from central maximum to first interference maximum. $n = 1$
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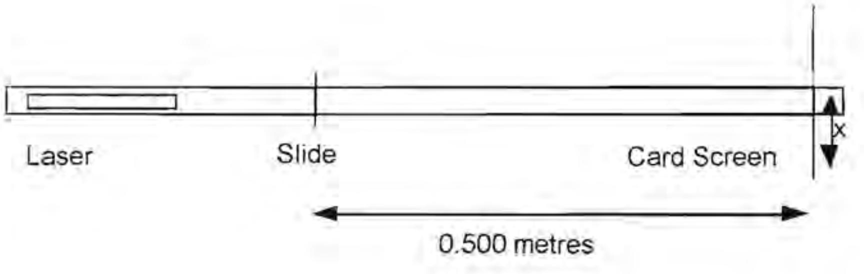
Hint : It is important that the laser is perpendicular to the slide and the white card.



Result:

Conclusion: Diffraction around the hair produces a situation where each edge of the hair is equivalent to a point source resulting in an interference pattern.

Risk Level: Moderate Hazard: Lasers can cause eye damage and should remain in the control of the teacher at all times.

STUDENT:________________

2 A Leaf is a Leaf

Aim: To investigate the variety found in the plant kingdom.

Equipment

Procedure

Collect all the different leaves you can findin the school grounds.

The leaves should be collected as a stem with at least three leaves.

Back in the classroom arrange the class collection into groups: Palmate, Ovoid, Needle, Blade, Compound.

Choose a leaf and describe how it is different from other leaves in its group eg. edging, leaf hairs, venation, stem arrangement etc.

Draw the leaf.

Results: ____

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Conclusion: ____

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2

A Leaf is a Leaf

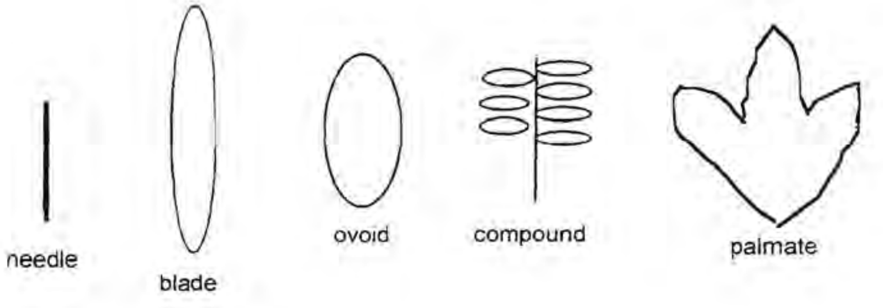
Topics: Plants Diversity Communities

Aim: To investigate the variety found in the plant kingdom.

Equipment

Procedure

Primer: Ask a student to draw a leaf on the board.
Take the students outside for a stroll around the school grounds collecting all the different leaves they can find.
The leaves should be collected as a stem with at least three leaves.
Back in the classroom arrange the collection into groups: Palmate, Ovoid, Needle,Blade, Compound.
Each student must pick a leaf and describe how it is different from other leaves in its group eg. edging, leaf hairs, venation, stem arrangement etc



Result: There is huge variety in simple things such as leaves.

Conclusion: The leaf structure of every family of plants is different. There is huge diversity in the plant kingdom if you look for it.

Risk Level: Low Hazard

STUDENT:________________

3 Adsorbtion

Aim: To demonstrate that certain substances will adsorb and remove dyes from solution.

Equipment

Activated Charcoal
Methylene Blue
Coca-Cola (flat)
test tubes and stoppers

Procedure

Activate 50g of charcoal by heating in a moderate oven for 1 hour.
Prepare a dye solution by adding methylene blue to 500ml of water until a deep colour is produced.
Add a teaspoon of charcoal powder to a test tube of the dye. Mix and allow to settle.
Repeat using Coca-Cola instead of dye.

Results: ____

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Conclusion: ____

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3

Adsorbtion

Topics: Separations Matter

Aim: To demonstrate that certain substances will adsorb and remove dyes from solution.

Equipment

Activated Charcoal
Methylene Blue
Coca-Cola (flat)
test tubes and stoppers

Procedure

Activate 50g of charcoal by heating in a moderate oven for 1 hour.
Prepare a dye solution by adding Methylene blue to 500ml of water until a deep colour is produced.
Add a teaspoon of powder to a test tube of dye.
Mix and allow to settle.
Repeat using Coca-Cola instead of dye.

Result: The charcoal settled taking the colour of the solution with it.

Conclusion: Activated charcoal adsorbs molecules to its surface and is very useful in removing some dissolved impurities from water.

Risk Level: Low Hazard: Methylene blue is a strong dye that can stain skin and clothes.

STUDENT: ________________

4 Adaptations 1

Aim: To examine various plant seeds and deduce the survival adaptations of each.

Equipment

Seeds : Eucalyptus
Farmers Friend
Dandelion
Apple
Macadamia
Black Bean

Procedure

Draw the seeds.
Examine each seed and deduce how it solves the problems of : (a) dispersal and (b) survival. Bear in mind the quantity of seed which might be produced by the plant.

Results: ____

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Conclusion: ____

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4

Adaptations 1

Topics: Adaptations Communities

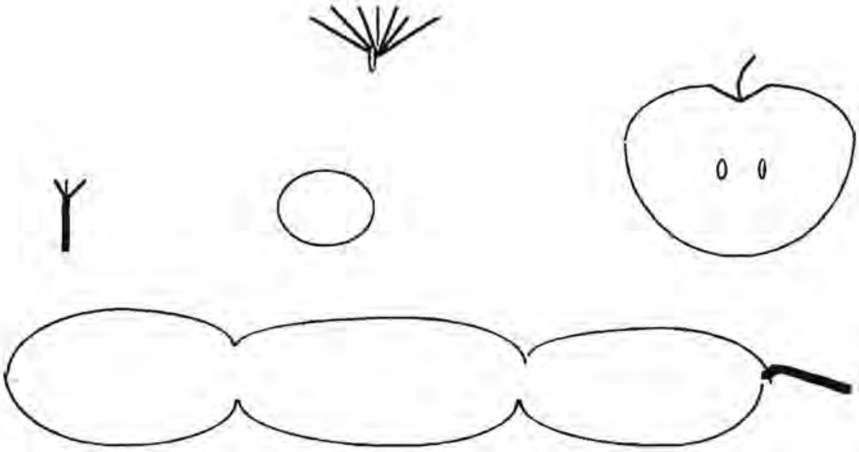
Aim: To examine various plant seeds and deduce the survival adaptations of each.

Equipment

Seeds : Eucalyptus
Farmers Friend
Dandelion
Apple
Macadamia
Black Bean

Procedure

Draw the seeds.
Examine each seed and deduce how it solves the problems of : (a) dispersal and (b) survival. Bear in mind the quantity of seed which might be produced by the plant.



Result: Each seed varies greatly in size, shape or structure.

Conclusion: Eucalypts rely on simple wind dispersal and shear quantity. Dandelion relies on augmented wind dispersal and quantity. Farmers Friend uses animal vectors allowing a larger seed and food store. Apples attract animals with fleshy fruit so the seeds are deposited in fertile dung. Macadamias may roll and are armoured, while black bean uses water dispersal.

Risk Level: Low

STUDENT:________________

5 Adaptations 2

Aim: To deduce the adaptations of an animal which help it fill a particular niche in a particular environment.

Equipment

Photocopy descriptions of ten different animals from an encyclopaedia.
Each group receives one animal.

Procedure

Read the description of the animal.
Describe the Physical Environment of the Animal.
Describe the Biotic Environment of the animal.
Describe the Habitat of the animal.
Describe the Niche filled by the animal.
Describe any adaptations of the animal which may help it survive.

Results: ________________________________

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Conclusion: ________________________________

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5

Adaptations 2

Topics: Adaptations Communities

Aim: To deduce the adaptations of an animal which help it fill a particular niche in a particular environment.

Equipment

Photocopy descriptions of ten different animals from an encyclopaedia.
Each group receives one animal.

Procedure

Read the description of the animal.
Describe the Physical Environment of the Animal.
Describe the Biotic Environment of the animal.
Describe the Habitat of the animal.
Describe the Niche filled by the animal.
Describe any adaptations of the animal which may help it survive.

Result:

Conclusion: Excellent revision exercise.

Risk Level: Low

STUDENT: ____________________

6 Aerodynamics

Aim: To make a simple boomerang incorporating the aerofoil shape.

Equipment

Simple Rulers (curved upper surface)
Rubber bands

Procedure

Use a rubber band to join two wooden rulers into a cross shape. Ensure both curved surfaces are in the same direction.

1.Go down to the oval and try to fly your boomerang with a flicking motion and the curved surfaces upward.

2.Try the boomerang inverted.

3.Try the boomerang with one ruler inverted ie. curved surfaces opposite.

In the space below, draw the flight path of each configuration.

Results: ____

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Conclusion: ____

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TEACHER COPY

6

Aerodynamics

Topics: Pressure/Density Flight

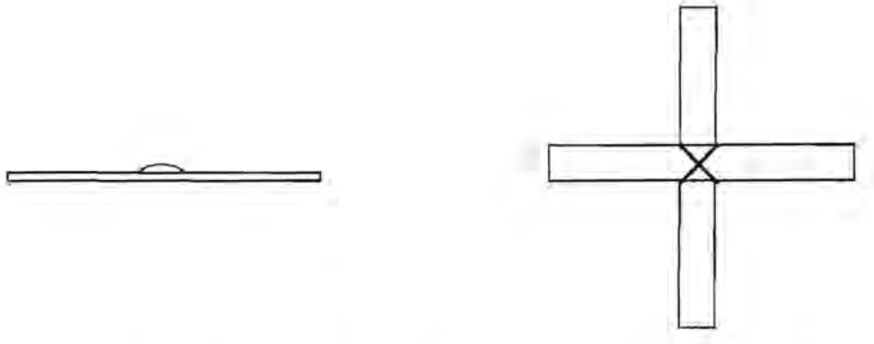
Aim: To make a simple boomerang incorporating the aerofoil shape.

Equipment

Simple Rulers (curved upper surface)
Rubber bands

Procedure

Use a rubber band to join two wooden rulers into a cross shape. Ensure both curved surfaces are in the same direction.
Go down to the oval and try to fly your boomerang with a flicking motion and the curved surfaces upward.
Try the boomerang inverted.
Try the boomerang with one ruler inverted ie. curved surfaces opposite.



Result: Maximum lift is achieved with both curved surfaces upward.

Conclusion: The curved upper surface causes air to move further over the upper surface than the lower. As Bernoulli found, when air moves faster, pressure is reduced. As a result, pressure beneath the wing is higher than above the wing, thereby creating "Lift".

Risk Level: Low Hazard; Provided all students stay back while test flights are in progress.

STUDENT:________________

7 Air Borne Microbes

Aim: To demonstrate that the air contains many microbes.

Equipment

Glass Petri dishes,5
Heat resistant, plastic tray
Agar Agar
Vegemite
Beaker, 250ml

Procedure

Add 2g of agar to 100ml water in the beaker.
Heat until the agar dissolves then mix in 1 teaspoon of Vegemite or Promite.
Pour enough of the hot solution into each dish to cover the base.
Sterilise the plates either by 20mins in a pressure cooker or heating in a microwave until the agar boils.
Allow the plates to cool and gel.

Seal one plate.

Expose one plate to air for 1min, another for 5min, another to a finger touch, another to a cough, another to a sprinkle of fresh soil.
Leave in a dark, warm place for several days.
In the space below, draw the plates as the appear now.

Results: ____

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Conclusion: ____

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7

Air Borne Microbes

Topics: Microbes & Immunity Cells

Aim: To demonstrate that the air contains many microbes.

Equipment

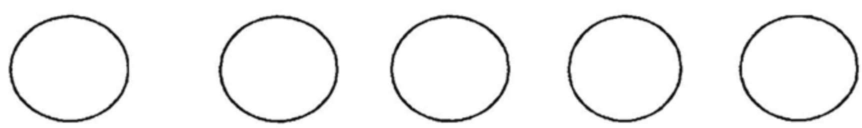
Glass Petri dishes,5
Heat resistant, plastic tray
Agar Agar
Vegemite
Beaker, 250ml

Procedure

Add 2g of agar to 100ml water in the beaker.
Heat until the agar dissolves then mix in 1 teaspoon of Vegemite or Promite.
Pour enough of the hot solution into each dish to cover the base.
Sterilise the plates either by 20mins in a pressure cooker or heating in a microwave until the agar boils.
Allow the plates to cool and gel.

Seal one or more plates as a control.

Expose one plate to air for 1min, another for 5min, another to a finger touch, another to a cough, another to a sprinkle of fresh soil.
Leave in a dark, warm place for several days.



Result: No growth or colonies were found on the sealed plates but all exposed plates showed fungal and bacteria colonies.

Conclusion: Microbial spores abound in the environment surrounding us.

Risk Level: BIOLOGICAL HAZARD: The plates are not to be opened but processed in boiling water as soon as observations have been recorded.

STUDENT:__________________

8 Alcohols

Aim: To observe the reactions of primary, secondary and tertiary alcohols.

Equipment

6 large test tubes
Bunsen,tripod and gauze
3 Dropper bottles
Potassium Permanganate 0.01M (0.2%) 5ml
Sulfuric Acid 6M(32%) 5ml
Butanol (Primary)
2-Butanol (Secondary)
2-Methyl- 2- Propanol
Thermometer
Pipette filler
pipettes,4

Procedure

Place 2ml samples of each alcohol in three test tubes.
Add 1ml of acid TO 2ml of the permanganate reagent.
Add 3 to 5 drops of the acidified permanganate to the test tubes and shake gently.
Carefully smell the test tubes.
Record whether the alcohol has changed in each case.

Results: ____

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Conclusion: ____

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TEACHER COPY

8

Alcohols

Topics: Organic Chem Energy in Life

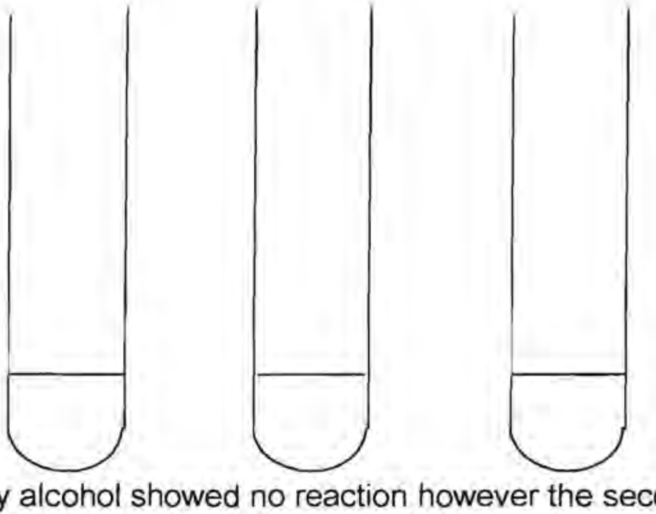
Aim: To observe the reactions of primary, secondary and tertiary alcohols.

Equipment

6 large test tubes
Bunsen,tripod and gauze
3 Dropper bottles
Potassium Permanganate 0.01M (0.2%) 5ml
Sulfuric Acid 6M(32%) 5ml
Butanol (Primary)
2-Butanol (Secondary)
2-Methyl- 2- Propanol
Thermometer
Pipette filler
pipettes,4

Procedure

Place 2ml samples of each alcohol in three test tubes.
Add 1ml of acid TO 2ml of the permanganate reagent.
Add 3 to 5 drops of the acidified permanganate to the test tubes and shake gently.
Carefully smell the test tubes.



Result: The tertiary alcohol showed no reaction however the secondary and primary alcohols did oxidise but to different products.

Conclusion: Primary alcohols can be oxidised to alkanoic acids but secondary alcohols are oxidised to alkanones.

Risk Level: HAZARDOUS: SENIOR STUDENTS ONLY- Alcohols are highly inflammable and must be kept from naked flames. 6M Sulfuric acid is highly corrosive and any skin contact must be vigorously washed. Permanganate solutions are harmful if ingested and skin contact causes staining.

STUDENT:________________

9 Alfoil Attractions

Aim: To demonstrate the force between two current carrying conductors.

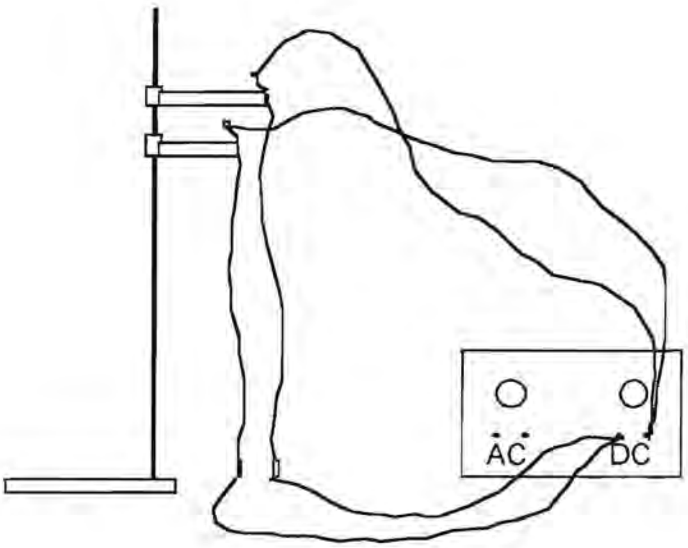
Equipment

Alfoil strips,5cm X 30cm,2
Retort stand, clamp, 2
Power supply, 12V, DC
Connecting leads, 4
Alligator clips, 4

Procedure

Arrange two clamps on the retort stand about 40cm from the base.
Grip a connecting lead banana plug in each clamp.
Use alligator clips to attach an alfoil strip to each plug.
Adjust the strips so they hang about 3cm apart.
Use alligator clips to attach a connecting lead to the base of each strip.
Connect the leads to the Power supply, DC, 6V, so that the top each strip is positive and the base negative.
Turn on the power in brief bursts.

Reverse the current flow in one strip.
Turn on the power in bursts.



Results: ________________________________

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Conclusion: ________________________________

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9

Alfoil Attractions

Topics: Electromagnetism

Aim: To demonstrate the force between two current carrying conductors.

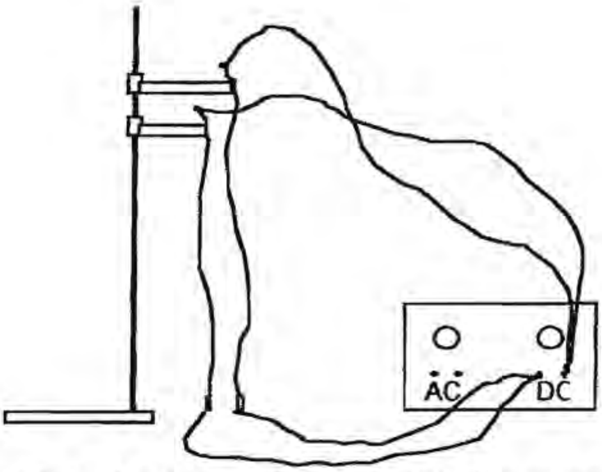
Equipment

Alfoil strips,5cm X 30cm,2
Retort stand, clamp, 2
Power supply, 12V, DC
Connecting leads, 4
Alligator clips, 4

Procedure

1/ Arrange two clamps on the retort stand about 40cm from the base.
2/ Grip a connecting lead banana plug in each clamp.
3/ Use alligator clips to attach an alfoil strip to each plug.
4/ Adjust the strips so they hang about 0.5cm apart.
5/ Use alligator clips to attach a connecting lead to the base of each strip.
6/ Connect the leads to the Power supply, DC, 6V, so that the top each strip is positive and the base negative.
7/ Turn on the power in brief bursts.

Reverse the current flow in one strip.
Turn on the power in bursts.
Hint: The lower clips may have to be supported so that there is a minimum of wieght on the alfoil strips.



Result: Parallel aluminium sheets carrying current in the same direction belly toward each other but when the current is reversed in one strip, they belly away from each other.

Conclusion: When current flows in a conductor a circular magnetic field is created so that on opposite sides of the wire the field direction is also opposite. Two parallel wires carrying current in the same direction will have opposite fields between and so attract each other.

Risk Level: Low Hazard: Large currents will flow due to the low resistance of the circuit and this may trip the circuit breaker in the power supply.

STUDENT:________________

10 Are You Quick?

Aim: To demonstrate the time required for neural messages, that is response time from observation to reaction.

Equipment

$5 note or piece of paper no longer than 15cm.

Procedure

One student holds the note.
A second student holds forefinger and thumb either side of the middle of the note, their hand resting on a table edge.
Without warning the first student releases the note.
The second student attempts to grab it between finger and thumb.

Results: ____

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Conclusion: ____

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10

Are You Quick?

Topics: Coordination

Aim: To demonstrate the time required for neural messages, that is response time from observation to reaction.

Equipment

$5 note or piece of paper no longer than 15cm.

Procedure

One student holds the note.
A second student holds forefinger and thumb either side of the middle of the note, their hand resting on a table edge.
Without warning the first student releases the note.
The second student attempts to grab it between finger and thumb.

Result: No one was able to catch the note unless they anticipated its release.

Conclusion: Response time is approximately 0.1 seconds. Any falling object will travel 10cm in this time. Since the distance from the centre of the note to its end is no more than 7.5cm it is impossible to catch.

Risk Level: Low Hazard (except to your money).

STUDENT:________________

11 Attwoods Machine

Aim: To determine the acceleration due to gravity using Attwoods Machine

Equipment

Mass Carriers, 2
Masses, 50g(2), 25g, 5g(2)
Single pulley
Retort Stand, clamp
String, 1.5m
metre rule,
stop watch

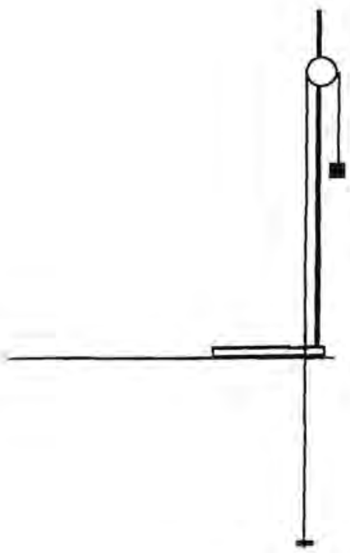
Procedure

Pass the string through the pulley and tie a mass carrier to each end.
Support the pulley using the retort so there is a metre of travel to the floor.
Add 50g to one carrier (M1).
Add 75g to the other carrier (M2).
Record the time required for the heavier pulley to fall 1 metre to the floor.

$S = ut + 1/2\ at^2$ therefore in this case $a = 2/t^2$
Net force = $(M2-M1)g$
Acceleration = Net force/ Total mass

$$2/t^2 = (M2 - M1)g\ /\ (M2 + M1)$$

$$g = 2/t^2\ (M2 + M1)\ /\ (M2 - M1)$$



Results: ____

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Conclusion: ____

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11

Attwoods Machine

Topics: Forces

Aim: To determine the acceleration due to gravity using Attwoods Machine

Equipment

Mass Carriers, 2
Masses, 50g(2), 25g, 5g(2)
Single pulley
Retort Stand, clamp
String, 1.5m
metre rule,
stop watch

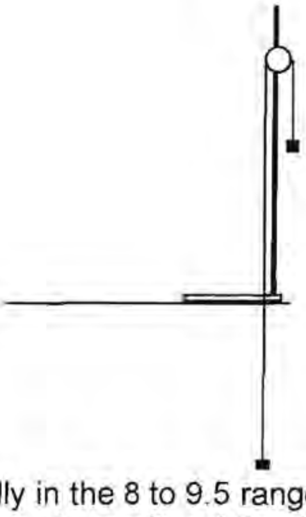
Procedure

Pass the string through the pulley and tie a mass carrier to each end.
Support the pulley using the retort so there is a metre of travel to the floor.
Add 50g to one carrier (M1).
Add 75g to the other carrier (M2).
Record the time required for the heavier pulley to fall 1 metre to the floor.

$S = ut + 1/2\ at^2$ therefore in this case $a = 2/t^2$
Net force = (M2-M1)g
Acceleration = Net force/ Total mass

$$2/t^2 = (M2 - M1)g / (M2 + M1)$$

$$g = 2/t^2\ (M2 + M1) / (M2 - M1)$$



Result: Results for g are usually in the 8 to 9.5 range, better results being obtained when the mass difference is small and the time measurement more accurate.

Conclusion: The figure for g should be less than 9.8 allowing for air friction, pulley friction and pulley inertia. this is a good practical assessment task if the theory equations are presented in an introduction.

Risk Level: Low Hazard

STUDENT:________________

12 Ballistic Arrow

Aim: Aim to determine the velocity of an arrow and the force applied by the bow.

Equipment

Bow, 2 arrows
Inclinometer
Stopwatch
Trundle Wheel
Metre rule
Balance

Procedure

Weigh an arrow.
At the school oval, use the inclinometer to check that the firing angle of the bow is 45 degrees.
Use the ruler to measure how far back the arrow is drawn.
Fire the arrow.
Repeat with the second arrow.
Use the trundle wheel to measure how far the arrows travelled.

For 45 degrees

range = v^2/g, or v^2 = range / g , (g = 9.8)

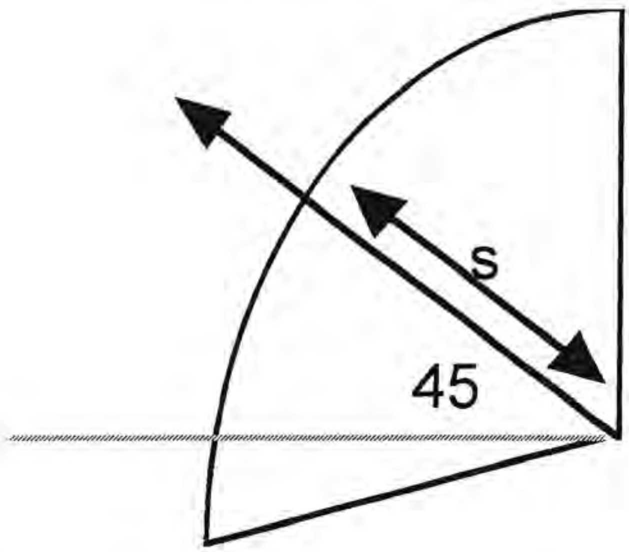
v = ________

since KE = work done

$1/2mv^2 = Fs$ where all variables are known except F

$F = mv^2 / 2s$

F = ________



Results: ____

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Conclusion: ____

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12

Ballistic Arrow

Topics: Forces Projectiles

Aim: Aim to determine the velocity of an arrow and the force applied by the bow.

Equipment

Bow, 2 arrows
Inclinometer
Stopwatch
Trundle Wheel
Metre rule
Balance

Proceedure

Weigh an arrow.
At the school oval, use the inclinometer to check that the firing angle of the bow is 45 degrees.
Use the ruler to measure how far back the arrow is drawn.
Fire the arrow.
Repeat with the second arrow.
Use the trundle wheel to measure how far the arrows travelled.

For 45 degrees

range = v^2/g, or v^2 = range / g
since KE = work done
$1/2mv^2 = Fs$ where all variables are known except F

Result:

Conclusion: Arrows suffer considerable friction loss on their velocity. A reasonable approximation would be to add 25% to your calculated value of v to determine the the launch velocity. The major source of error here is the angle of inclination. The stop watch can be used for a separate calculation of v.

Risk Level: Moderate Hazard: All students must remain behind the archer until both arrows are fired. Be sure no passers-by might wander into the firing line.

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013 Batteries 1

Topics: Ions Electricity

Aim: To generate an electric current from a lemon.

Equipment

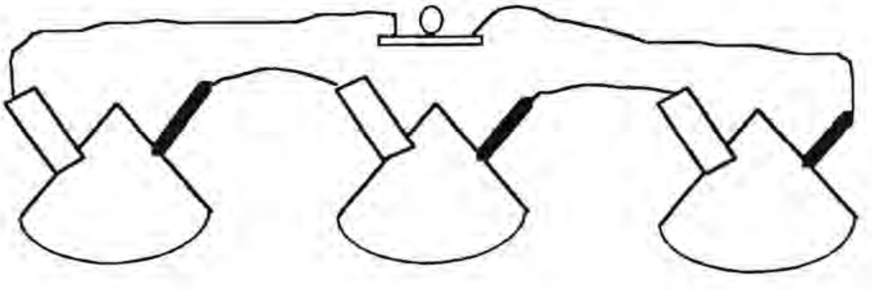
Iron Nails, three
Copper wires, 15cm, three
Lemon
Light globe,3V, in stand
connecting leads, two
Alligator clips, two

Note: Ensure that the nails and copper wire ends have been cleaned with steel wool.

Procedure

1/ Cut the lemon into three slices.
2/ Insert a nail into each slice.
3/ Insert copper wire into each slice about 2cm from the nail.
4/ Connect two slices together by twisting the free end of the copper wire to the nail on the next slice.
5/ Add the third slice to the row in the same manner.
6/ Connect a lead from the globe to the free copper wire at one end of the row by using an alligator clip.
7/ Connect the other side of the globe to the nail at the opposite end of your lemon row.

Draw the classroom blinds if the natural light is strong.
Note: If lemons are unavailable use three small beakers of salt solution.
Note: Connecting the cells in series produces sufficient voltage to light the lamp. Single cells can be tested with a Millivolt Meter.



Result: The globe glows dimly.

Conclusion: An electric current will flow between two dissimilar metals placed in a salt or acid solution.

Risk Level: Low Hazard

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13

Batteries 1

Topics: Ions Electricity

Aim: To generate an electric current from a lemon.

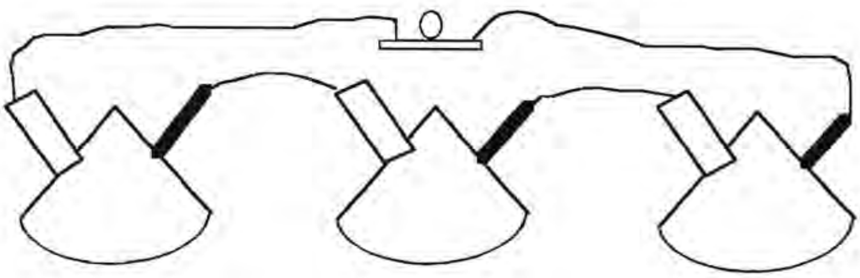
Equipment

Iron Nails, three
Copper wires, 15cm, three
Lemon
Light globe,3V, in stand
connecting leads, two
Alligator clips, two

Procedure

Cut the lemon into three slices.
Insert a nail into each slice.
Insert copper wire into each slice about 2cm from the nail.
Connect two slices together by twisting the free end of the copper wire to the nail on the next slice.
Add the third slice to the row in the same manner.
Connect a lead from the globe to the free copper wire at one end of the row by using an alligator clip.
Connect the other side of the globe to the nail at the opposite end of your lemon row .

Draw the classroom blinds if the natural light is strong.
Note: If lemons are unavailable use three small beakers of salt solution.
Note: Connecting the cells in series produces sufficient voltage to light the lamp. Single cells can be tested with a Millivolt Meter.



Result: The globe glows dimly.

Conclusion: An electric current will flow between two dissimilar metals placed in a salt or acid solution.

Risk Level: Low Hazard

STUDENT:____________________

14 Batteries 2

Aim: To determine the minimum requirements for a battery.

Equipment

Beaker, 250ml
Connecting leads, two
Voltmeter, 0 -2V
Iron Nails, two
Copper Strips, two
Sodium Chloride
Copper Carbonate
Distilled Water
Alligator clips, two

Procedure

Pour 100mls of distilled water into the beaker.
Using an alligator clip connect a nail to a lead and then to the negative terminal of the voltmeter.
Place the nail into the water (electrode 1).
Using an alligator clip connect a copper strip to a lead and then to the positive electrode of the voltmeter.
Place the copper strip into the water (Electrode 2).
Ensure the electrodes are not touching and record the voltage._____
Add a spatula of Copper carbonate to the water and stir.

Record the voltage._______
Replace the solution with tap water and add a spatula of sodium chloride, stir and record the voltage._____
Replace electrode 1 with a copper strip and record voltage.__
Replace both electrodes with nails and record the voltage. __
In the space below, draw the apparatus that produced the most voltage.

Results: ____

____

____

Conclusion: ____

____

____

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14

Batteries 2

Topics: Ions Electricity

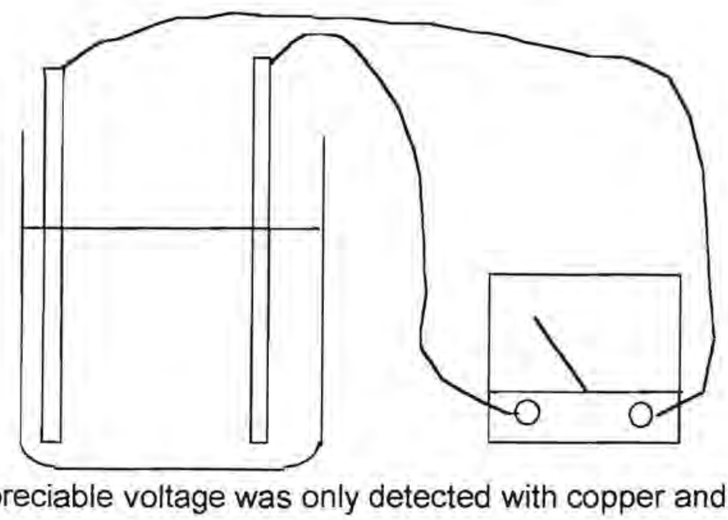
Aim: To determine the minimum requirements for a battery.

Equipment

Beaker, 250ml
Connecting leads, two
Voltmeter, 0 -2V
Iron Nails, two
Copper Strips, two
Sodium Chloride
Copper Carbonate
Distilled Water
Alligator clips, two

Procedure

Pour 100mls of distilled water into the beaker.
Using an alligator clip connect a nail to a lead and then to the negative terminal of the voltmeter.
Place the nail into the water (electrode 1).
Using an alligator clip connect a copper strip to a lead and then to the positive electrode of the voltmeter.
Place the copper strip into the water (Electrode 2).
Ensure the electrodes are not touching and record the voltage.
Add a spatula of Copper carbonate to the water and stir.
Record the voltage
Replace the solution with tap water and add a spatula of sodium chloride, stir and record the voltage.
Replace electrode 1 with a copper strip and record voltage.
Replace both electrodes with nails and record the voltage.
In this experiment there are three "controls", water only, both electrodes copper and both electrodes iron.



Result: An appreciable voltage was only detected with copper and iron in a salt solution.

Conclusion: For a current to be produced, two dissimilar metals must be placed in a conducting ionic solution. Copper carbonate is insoluble and produces no ions for a reaction to take place. Two identical electrodes will give a potential difference to drive the current.

Risk Level: Mild Hazard: Copper carbonate is harmful if ingested.

STUDENT:________________

15 Bending Water

Aim: To demonstrate that water is attracted by an electrostatic charge.

Equipment

Perspex Rod
Silk Cloth

Procedure

Adjust the flow of a water tap until only a very thin stream emerges not quite breaking into droplets.
Charge the rod by rubbing with the cloth.
Hold the rod close to the water.

Results: ____

____

____

Conclusion: ______________________________________

____

____

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15

Bending Water

Topics: Atoms Electrostatics Solubility

Aim: To demonstrate that water is attracted by an electrostatic charge.

Equipment

Perspex Rod
Silk Cloth

Procedure

Adjust the flow of a water tap until only a very thin stream emerges not quite breaking into droplets.
Charge the rod by rubbing with the cloth.
Hold the rod close to the water.

Result: The stream of water bends toward and even partly around the perspex rod.

Conclusion: Water contains molecules that can be attracted by an electrostatic charge (ie. molecules of water are polar).

Risk Level: Low Hazard

STUDENT: ____________________

16 Bernoulli Effect

Aim: To observe the effects of reduced air pressure accompanying higher air flow.

Equipment

Air pump
Ping pong Ball
Beaker
Glass Tubing , 10mm
venturi tap pump
Hose to connect air and venturi pump

Procedure

1/ Try balancing the ping pong ball in a vertical air flow.

2/ Place some water in the beaker.
Place the glass tube vertically in the water.
Direct the air flow across the top of the tube.
Draw the result of this experiment in the space below.

3/ Place the venturi draw hose in the beaker.
Connect the air pump to the venturi inlet (beware of the spray).

Results: ____

____

____

Conclusion: ____

____

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16

Bernoulli Effect

Topics: Air Flight Pressure/Density

Aim: To observe the effects of reduced air pressure accompanying higher air flow.

Equipment

Air pump
Ping pong Ball
Beaker
Glass Tubing , 10mm
venturi tap pump
Hose to connect air and venturi pump

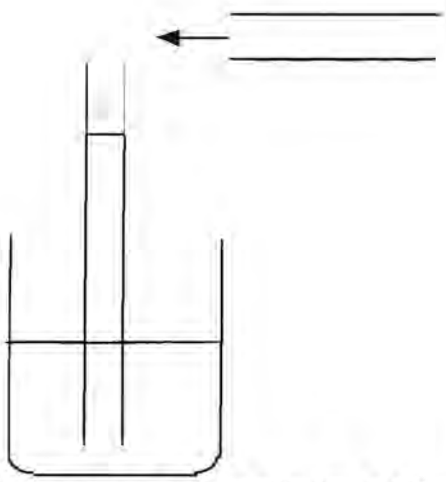
Procedure

1/ Try balancing the ping pong ball in a vertical air flow.

2/ Place some water in the beaker.
Place the glass tube vertically in the water.
Direct the air flow across the top of the tube.

3/ Place the venturi draw hose in the beaker.
Connect the air pump to the venturi inlet (beware of the spray - great demo of carburettor function).

4/ Demonstrate the venturi also works on water flow ie. off the tap.



Result: The ping pong ball becomes trapped in the air flow. Water rises in the glass tube. Water is drawn into the venturi and sprayed out the other end.

Conclusion: Rapid air or water flow creates a low pressure area. The surrounding higher pressure creates a net force to raise liquids or restore the ping pong ball to the low pressure centre flow.

Risk Level: Low Hazard : unless some bright spark tries to out blow the air pump.

STUDENT: ____________________

17 Big Lift

Aim: To observe the effect of mechanical disadvantage.

Equipment

Black board ruler
2kg mass

Procedure

Lift a 2kg mass.
Lift the mass from a table with their arm outstretched.
Place the mass on the end of the blackboard ruler.
Grasp the other end of the ruler and lift the mass keeping your arm straight.
What do you notice? Can you explain this phenomenon?

Results: ____

____

____

Conclusion: ____

____

____

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17

Big Lift

Topics: Forces Machines

Aim: To observe the effect of mechanical disadvantage.

Equipment

Black board ruler
2kg mass

Procedure

Invite a student to lift a 2kg mass.
Ask the student to lift the mass from a table with their arm outstretched.
Place the mass on the end of the blackboard ruler.
Ask the student to grasp the other end of the ruler and lift the mass keeping their arm straight.

Result: It is more difficult to lift the mass with the arm straight and much harder again using the ruler.

Conclusion: The arm represents a third order lever, the force being applied between the fulcrum and the load. All third order levers are movement magnifiers not force magnifiers. Extending the arm via the ruler simply multiplies the mechanical disadvantage already at work.

Risk Level: Low Hazard

STUDENT:________________

18 Blue Bottle

Aim: To demonstrate a reversible reaction.

Equipment

Glucose (not sucrose)
Sodium Hydroxide
Methylene Blue
Conical Flask and stopper

Procedure

Dissolve Glucose to 1% approximately.
Add Methylene Blue sufficient to produce a deep colour.
Add sodium hydroxide to about 1%.
Insert the stopper.
After a few minutes, shake the bottle.

Results: ____

____

____

Conclusion: _______________________________________

____

____

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18

Blue Bottle

Topics: Equilibrium Chemical reactions

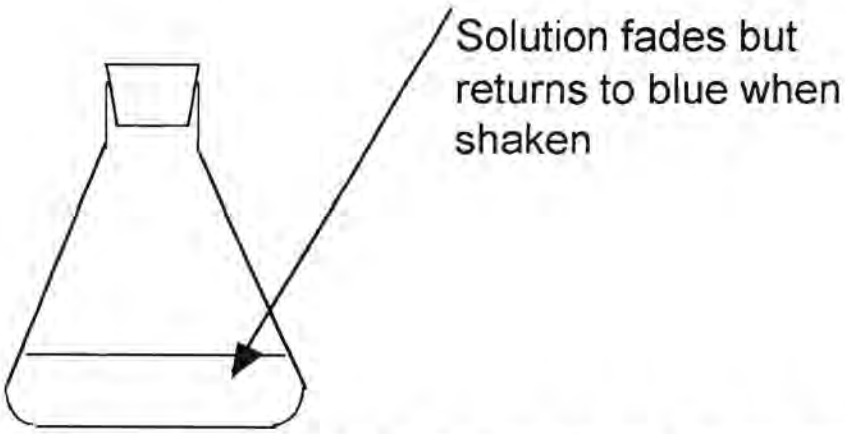
Aim: To demonstrate a reversible reaction.

Equipment

Glucose (not sucrose)
Sodium Hydroxide
Methylene Blue
Conical Flask and stopper

Procedure

Dissolve Glucose to 1% approximately.
Add Methylene Blue sufficient to produce a deep colour.
Just before the demonstration add sodium hydroxide to about 1%.



Result: The blue colour gradually fades. Shaking the bottle returns the dye to original blue.

Conclusion: The blue colour gradually fades due to reduction of the Methylene blue by the reducing sugar glucose. Shaking the bottle dissolves oxygen in the solution, driving the reaction in the reverse direction, oxidising the dye back to original blue.

Risk Level: HAZARDOUS: TEACHER DEMO OR SENIOR STUDENTS ONLY. Sodium hydroxide is highly caustic and shaking the solution introduces the risk of flying spillages. Methylene Blue is a strong vital dye which will stain skin and clothes.

STUDENT:________________

19 Body Language

Aim: To observe body language.

Equipment

Procedure

Rule lines across the space below.

Observe a guest speaker who is not aware they are being watched eg. a career talk.

In the space below, write down some of the hand movements, gestures and body postures used by the speaker.

Results: ____

____

____

Conclusion: ____

____

____

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19

Body Language

Topics: Coordination

Aim: To observe body language.

Equipment

Procedure

Observe a guest speaker who is not aware they are being watched eg. a career talk.
The students write down all the behaviours of the speaker.
Class discussion of important behaviours.

Reenactment of scenarios where body language is important eg. an interview.

Throw an object on the floor and in the same voice ask a student to pick it up but with the following variations.

1. Head bowed looking down- supplication
2. Back turned - dismissive
3. Looking straight at the student - request
4. Up close, eye contact, feet spread, hands on the table - demand.

Result: The same words give different messages depending on body posture.

Conclusion: Body language is a subtle but important form of communication.

Risk Level: Low Hazard

STUDENT:________________

20 Breathalyser

Aim: To produce a device to detect alcohol.

Equipment

Potassium Permanganate
Sulfuric Acid, 3M, 16%
Plastic straw
Silica Gel
Cotton wool
Ethanol
Beaker, 250 ml
Filter Paper, 3
Filter funnel
Conical flask,250ml
Spatula
Forceps
watch glass

Procedure

Add 50ml of sulfuric acid to the beaker.
Dissolve 1g potassium permanganate in the acid.
Add 20g of dry silica gel crystals.
After 10minutes pour the mixture into a filter funnel supported in a conical flask.
Using forceps remove the filter paper and spread the silica gel onto a fresh filter paper.
Crush the gel using a spatula.
Use the spatula to force gel into 2cm of a plastic straw.
Plug both ends of the straw with cotton wool.

Pour a little alcohol into a watch glass.
Dip the end of the straw distant from the silica gel into the alcohol.
Dry the straw and then blow through the alcohol treated end.

Results: ____

____

____

Conclusion: ____

____

____

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20

Breathalyser

Topics: Organic Chemistry

Aim: To produce a device to detect alcohol.

Equipment

Potassium Permanganate
Sulfuric Acid, 3M, 16%
Plastic straw
Silica Gel
Cotton wool
Ethanol
Beaker, 250 ml
Filter Paper, 3
Filter funnel
Conical flask,250ml
Spatula
Forceps
watch glass

Procedure

Add 50ml of sulfuric acid to the beaker.
Dissolve 1g potassium permanganate in the acid.
Add 20g of dry silica gel crystals.
After 10minutes pour the mixture into a filter funnel supported in a conical flask.
Using forceps remove the filter paper and spread the silica gel onto a fresh filter paper.
Crush the gel using a spatula.
Use the spatula to force gel into 2cm of a plastic straw.
Plug both ends of the straw with cotton wool.

Pour a little alcohol into a watch glass.
Dip the end of the straw distant from the silica gel into the alcohol.
Dry the straw and then blow through the alcohol treated end.

Result: The silica gel undergoes a colour change in response to the passage of alcohol vapours.

Conclusion: Primary alcohols are oxidised by acidified permanganate into alkanals, in the process the permanganate ion is altered and changes colour.

Risk Level: HAZARDOUS: Sulfuric acid (3M) is highly corrosive and any skin contact should be treated immediately with vigorous washing. Rubber gloves are recommended for the packing of the straw. Potassium permanganate stains the skin and is harmful if ingested. Benches should be wiped down with a damp cloth after the experiment.

STUDENT:________________

21 Buffers

Aim: To investigate the properties of a buffered solution.

Equipment

Beaker, 250ml
Burette,
Universal Indicator
Hydrochloric Acid, 0.01M, 0.1%
Balance, 0.1g sensitivity
Potassium Dihydrogen Phosphate
Di - sodium hydrogen phosphate

Procedure

Add 100ml of water to the beaker.
Add 5 drops of Indicator.
Fill the burette with the acid.
Slowly add acid to water while stirring.
Note the amount of acid added for each colour change.
Replace the water in the beaker.
Dissolve 1.22g of potassium dihydrogen phosphate.
Dissolve 4.00 g of di - sodium hydrogen phosphate.
Add 5 drops of indicator.
Add acid slowly while stirring.

Note the amount of acid added for each colour change.

Hint: students may need to repeat the first part of the experiment as the colour changes will initially be rapid.

Colour	Water	Buffer
	Acid added	Acid added

Results: ________________________________

____

____

Conclusion: ________________________________

____

____

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21

Buffers

Topics: Equilibrium Acids/ Bases

Aim: To investigate the properties of a buffered solution.

Equipment

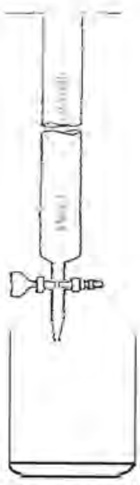
Beaker, 250ml
Burette,
Universal Indicator
Hydrochloric Acid, 0.01M, 0.1%
Balance, 0.1g sensitivity
Potassium Dihydrogen Phosphate
Di - sodium hydrogen phosphate

Procedure

Add 100ml of water to the beaker.
Add 5 drops of Indicator.
Fill the burette with the acid.
Slowly add acid to water while stirring.
Note the amount of acid added for each colour change.
Replace the water in the beaker.
Dissolve 1.22g of potassium Dihydrogen Phosphate.
Dissolve 4.00 g of Di - sodium hydrogen Phosphate.
Add 5 drops of indicator.
Add acid slowly while stirring.

Note the amount of acid added for each colour change

Hint: students may need to repeat the first part of the experiment as the colour changes will initially be rapid.



Result: More acid was required to make small changes in the pH of the buffer than was required for water.

Conclusion: Buffers resist pH changes.

Risk Level: Low Hazard: However to trust junior students with a burette requires firm class room control.

STUDENT: ____________________

22 Buoyancy

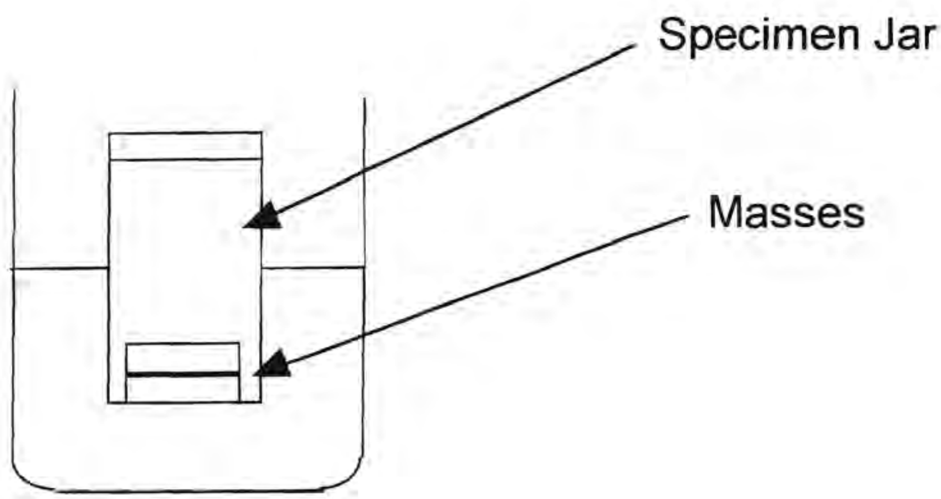
Aim: To deduce Pascals Principle.

Equipment

measuring cylinder, 100ml
specimen jar, plastic, 120ml
masses, five, 25g
marking pen

Procedure

Add 25mls of water to the specimen jar and mark its level
Repeat until the jar is marked to 100ml.
Pour out the water and add a 25g mass.
Place the jar in a large beaker of water and note the level at which it floats.
Add another 25g mass and mark the new level at which the jar floats.
Repeat this step three more times.



Results: ____

____

____

Conclusion: ____

____

____

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22

Buoyancy

Topics: Density/Pressure

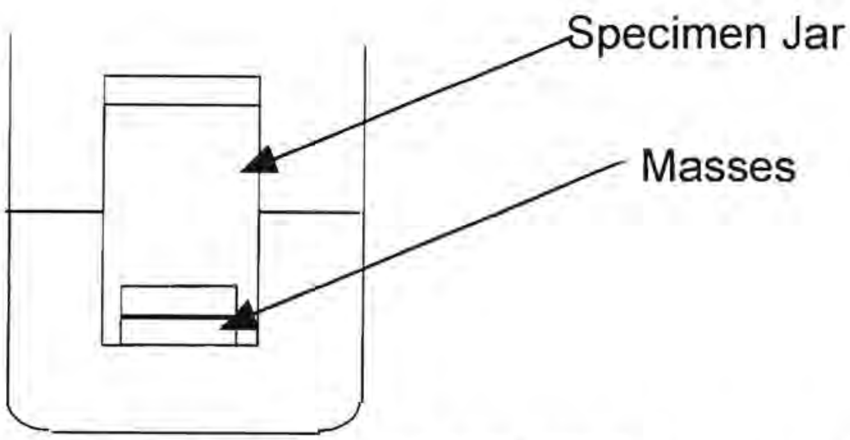
Aim: To deduce Pascals Principle.

Equipment

measuring cylinder, 100ml
specimen jar, plastic, 120ml
masses, five, 25g
marking pen

Procedure

Add 25mls of water to the specimen jar and mark its level
Repeat until the jar is marked to 100ml.
Pour out the water and add a 25g mass.
Place the jar in a large beaker of water and note the level at which it floats.
Add another 25g mass and mark the new level at which the jar floats.
Repeat this step three more times.



Result: The level at which the jar floats is roughly equal to mass added.

Conclusion: A floating object displaces water equal to its weight. As a result if an object is only half submerged when floating then its density must be half that of water.

Risk Level: Low Hazard

STUDENT:______________

23 Camouflage

Aim: To demonstrate the effectiveness of camouflage in avoiding predators.

Equipment

Coloured Tooth Picks

Procedure

Throw a packet of coloured tooth picks onto a grassed area of the school grounds.
The students pick up as may as they can find.
Each student sorts their collection into colours, counting how many of each type they find.
A class tally is made

Hint: Choose an area mown a few days ago.

Class Tally

Colour	Number Found

Results: ____

____

____

Conclusion: ____

____

____

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23

Camouflage

Topics: Communities Evolution

Aim: To demonstrate the effectiveness of camouflage in avoiding predators.

Equipment

Coloured Tooth Picks

Procedure

Throw a packet of coloured tooth picks onto a grassed area of the school grounds.
The students pick up as may as they can find.
Each student sorts their collection into colours, counting how many of each type they find.
A class tally is made

Hint: Choose an area mown a few days ago.

Result: The recovery of green and yellow tooth picks were poorest.

Conclusion: Green and yellow are difficult to find since they are camouflaged in a background of green leaves and yellow clippings.

Risk Level: Low Hazard

STUDENT:________________

24 Carbon Dioxide

Aim: To produce Carbon Dioxide and observe some of its properties.

Equipment

Sodium Carbonate
Hydrochloric Acid, 1M,10%
Test Tube
Wooden taper
Bunsen Burner

Procedure

Place a spatula of sodium carbonate in the test tube.
Light the Bunsen.
Add 2 or 3 cm of hydrochloric Acid to the test tube.
Collect the gas produced by blocking the test tube mouth.
Light the taper in the Bunsen flame.
Plunge the burning taper into the gas.
Draw the apparatus in the space below.

Results: ____

____

____

Conclusion: ____

____

____

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24

Carbon Dioxide

Topics: Chemical Reactions Matter Air

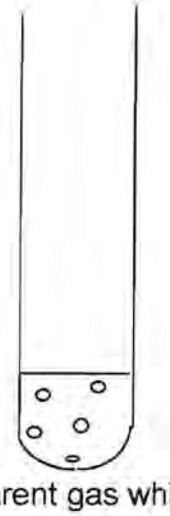
Aim: To produce Carbon Dioxide and observe some of its properties.

Equipment

Sodium Carbonate
Hydrochloric Acid, 1M,10%
Test Tube
Wooden taper
Bunsen Burner

Procedure

Place a spatula of sodium carbonate in the test tube.
Light the Bunsen.
Add 2 or 3 cm of hydrochloric Acid to the test tube.
Collect the gas produced by blocking the test tube mouth.
Light the taper in the Bunsen flame.
Plunge the burning taper into the gas.



Result: Carbon Dioxide is a transparent gas which extinguishes a flame.

Conclusion: Acid + Carbonate > Carbon Dioxide + Salt + Water

Risk Level: Mildly Hazardous: 1M Hydrochloric acid is mildly corrosive and skin contact should be treated with vigorous washing in water.

STUDENT:____________________

25 Carbonates & Oxides

Aim: To observe the reaction of Carbonates with acids.

Equipment

Test Tubes, large, two
Hydrochloric acid, 1M, 10%
Sulfuric Acid, 1M, 5.4%
Copper Carbonate
Magnesium Carbonate
Iron Carbonate
Wooden splints
Bunsen
Copper Oxide
Magnesium Oxide
Iron Oxide

Procedure

Add 3cm of sulfuric acid to one test tube.
Add 3cm of hydrochloric acid to the other test tube.
Add a small amount of copper carbonate to each tube.
Test the gas produced with a burning splint.
Clean the tubes and repeat for magnesium carbonate.
Clean the tubes and repeat the steps for iron carbonate.
Clean the tubes and repeat the steps for each oxide.

Test Substance	HCL reaction	Sufuric acid reaction
Copper Carbonate		
Magnesium Carbonate		
Iron Carbonate		
Copper Oxide		
Magnesium Oxide		
Iron Oxide		

Results: ____

____

____

Conclusion: ____

____

____

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25

Carbonates & Oxides

Topics: Salts Acids/ Bases Chemical Reactions

Aim: To observe the reaction of Carbonates with acids.

Equipment

Test Tubes, large, two
Hydrochloric acid, 1M, 10%
Sulfuric Acid, 1M, 5.4%
Copper Carbonate
Magnesium Carbonate
Iron Carbonate
Wooden splints
Bunsen
Copper Oxide
Magnesium Oxide
Iron Oxide

Procedure

Add 3cm of sulfuric acid to one test tube.
Add 3cm of hydrochloric acid to the other test tube.
Add a small amount of copper carbonate to each tube.
Test the gas produced with a burning splint.
Clean the tubes and repeat for magnesium carbonate.
Clean the tubes and repeat the steps for iron carbonate.
Clean the tubes and repeat the steps for each oxide.

Result: Each carbonate produces carbon dioxide gas and dissolves into soluble salt. The oxides appeared to produce the same salts but no gas.

Conclusion: ACID + CARBONATE > SALT + WATER + CARBON DIOXIDE
ACID + METAL OXIDE > SALT + WATER

Risk Level: Mild Hazard: Copper compounds are harmful if ingested. Sulfuric and hydrochloric acids are corrosive and any skin contact treated with vigorous washing.

STUDENT:________________

26 Cartesian Diver

Aim: To demonstrate the principle of a submarine and how it is possible to float at specific depths.

Equipment

Party Balloon
Large Measuring Cylinder
Small test tube
Rubber band

Procedure

Nearly fill the measuring cylinder with water.
3/4 fill the test tube with water and place inverted in the cylinder.
Adjust the air bubble until the test tube floats, just breaking the surface tension.
Stretch a piece of the balloon across the cylinder mouth using the rubber band to hold it in place.
Press firmly on the balloon membrane with three fingers.
Draw the apparatus in the space below.

Hint: Adjusting the test tube diver bubble may be more easily done in a sink or plastic tray using a wash bottle to add air to the bubble.

Results: ____

____

____

Conclusion: ____

____

____

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026

Cartesian Diver

Topics: Density/Pressure Forces

Aim: To demonstrate the principle of a submarine and how it is possible to float at specific depths.

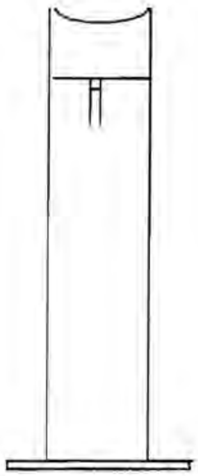
Equipment

Party Balloon
Large Measuring Cylinder
Small test tube
Rubber band

Procedure

1/ Nearly fill the measuring cylinder with water.
2/ 3/4 fill the test tube with water and place inverted in the cylinder.
3/ Adjust the air bubble until the test tube floats, just breaking the surface tension.
4/ Stretch a piece of the balloon across the cylinder mouth using the rubber band to hold it in place.
5/ Press firmly on the balloon membrane with three fingers.

Hint: Adjusting the test tube diver bubble may be more easily done in a sink or plastic tray using a wash bottle to add air to the bubble.
Alternative: A large plastic PET bottle can be used instead of a measuring cylinder. Diver adjustment is difficult but squeezing the bottle eazily produces a dive.



Result: The test tube will dive, rise or hover at a particular level depending on the pressure placed on the balloon membrane.

Conclusion: Pressure on the balloon membrane transfers pressure to the diver bubble causing it to compress and the overall density of the diver increases. The weight of the diver exceeds the water pressure difference between its tip and base and so it sinks.

Risk Level: Low Hazard

STUDENT:________________

27 Catalysis

Aim: To compare the rates of a reaction with and without a catalyst

Equipment

Sod. Pot. Tartarate
Cobalt Chloride
Hydrogen Peroxide, 6%
Beakers, 100ml, three
Thermometer
Bunsen and tripod
Measuring Cylinder, 100ml
Measuring Cylinder, 10ml
Balance, 0.1g accuracy

Hint: Hydrogen Peroxide can degrade in its container. Test a small amount in a test tube with some Manganese Dioxide

Procedure

Weigh 1g cobalt chloride in the small beaker and dissolve in 10ml of water.
Dissolve 2g tartarate in a beaker with 20ml of water.
Add 20ml of hydrogen peroxide.
Heat the solution to 65 degrees and then pour half of the solution into the second beaker.
Place both beakers on a sheet of white paper.
To the first beaker add 1ml of water.
To the second beaker add 1ml of cobalt chloride.

Results: ____

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Conclusion: ____

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27

Catalysis

Topics: Chemical Rns Activation Energy

Aim: To compare the rates of a reaction with and without a catalyst

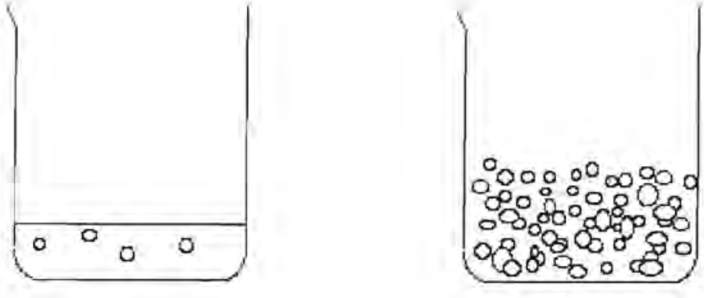
Equipment

Sod. Pot. Tartarate
Cobalt Chloride
Hydrogen Peroxide, 6%
Beakers, 100ml, three
Thermometer
Bunsen and tripod
Measuring Cylinder, 100ml
Measuring Cylinder, 10ml
Balance, 0.1g accuracy

Hint: Hydrogen Peroxide can degrade in its container. Test a small amount in a test tube with some Manganese Dioxide

Procedure

Weigh 1g cobalt chloride in the small beaker and dissolve in 10ml of water.
Dissolve 2g tartarate in a beaker with 20ml of water.
Add 20ml of hydrogen peroxide.
Heat the solution to 65 degrees and then pour half of the solution into the second beaker.
Place both beakers on a sheet of white paper.
To the first beaker (control) add 1ml of water.
To the second beaker add 1ml of cobalt chloride.



Result: The beaker with cobalt chloride effervesced vigorously compared to the control beaker. The cobalt chloride initially changed colour to green but then returned to red.

Conclusion: Cobalt chloride greatly accelerates the reaction between hydrogen peroxide and tartaric acid. the colour change demonstrates that Cobalt ions take part in the reaction but are not consumed since the colour returns to original red. Cobalt chloride is a catalyst of the reaction.

Risk Level: Moderate Hazard (Senior Students): Cobalt chloride is toxic if ingested and is known to be mutagenic. Hydrogen peroxide 6% should be isolated from flammable liquids or other oxidising agents. Hydrogen peroxide can be irritating to the skin, damaging to eyes and should not be ingested. Oxygen is produced and all flames should be extinguished before adding peroxide.

STUDENT: ________________

28 Centripetal Force

Aim: To confirm the equation for centripetal force.

Equipment

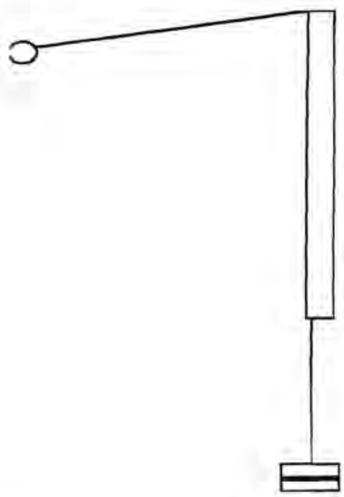
Glass tube, 10cm, sharp edges rounded in a flame
String, 1m
Mass Carrier
Masses
Fishing sinker, large
Marking pen
balance, 0.1g sensitivity
Ruler
Stopwatch

Procedure

Thread the string through the glass tube.
Weigh the sinker and tie it at one end of the string.
Mark the string at 10 and 15 cm from the sinker.
Tie the mass carrier to the other end of the string and adjust to 100g.
Holding the tube vertical, a student begins to swing the sinker in a horizontal circle until the radius is at the 10cm mark.
Record the time required for ten revolutions.
Repeat for the 15cm mark.

Repeat using 150g on the carrier.
Calculations:
$F = m_1 w^2 r = m_2 g$, m_1 = sinker mass, m_2 = mass carrier
$w = 6.28/\text{time}$ $g = 9.8$ r = radius

Use the formula to calculate the sinker mass.



Mass2	Radius	Time	Mass1

Results: ____

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Conclusion: ____

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28

Centripetal Force

Topics: Forces

Aim: To confirm the equation for centripetal force.

Equipment

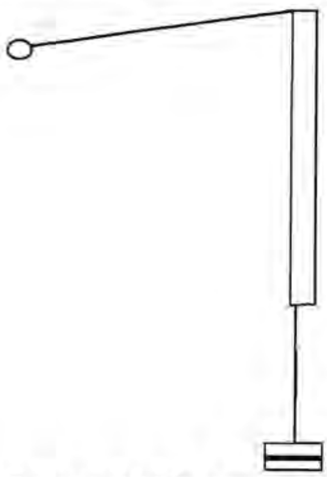
Glass tube, 10cm, sharp edges rounded in a flame
String, 1m
Mass Carrier
Masses
Fishing sinker, large
Marking pen
balance, 0.1g sensitivity
Ruler
Stopwatch

Procedure

Thread the string through the glass tube.
Weigh the sinker and tie it at one end of the string.
Mark the string at 10 and 15 cm from the sinker.
Tie the mass carrier to the other end of the string and adjust to 100g.
Holding the tube vertical, a student begins to swing the sinker in a horizontal circle until the radius is at the 10cm mark.
Record the time required for ten revolutions.
Repeat for the 15cm mark.

Repeat using 150g on the carrier.
Calculations:
$F = m_1 w^2 r = m_2 g$, m_1 = sinker mass, m_2 = mass carrier
$w = 6.28/\text{time}$ $g = 9.8$ r = radius

Use the formula to calculate the sinker mass.



Result: The calculations give figures which were consistently low for the sinker mass.

Conclusion: The main source of error here is that the swing circle of the sinker is actually a conical pendulum with the centripetal force being only one vector.

Risk Level: Mild Hazard : Remind the students not to hit themselves in the face with the sinker.

STUDENT: ________________

29

Chem Prac 1

Aim: To prepare magnesium sulfate heptahydrate from magnesium carbonate.

Equipment

Balance
Beaker, 100ml
Stirring Rod
Measuring Cylinder, 100ml
Filter funnel and paper
Retort stand & ring clamp
Evaporating Basin
Bunsen, tripod, gauze
Sulfuric acid ,1M (5.4%)
Magnesium Carbonate
Distilled water

Procedure

Weigh 2g of magnesium carbonate.
Write an equation for the conversion of magnesium carbonate to magnesium sulfate.
Calculate the quantity of reagents required for 2g of the carbonate.
Draw a flow diagram showing how you would use the equipment to achieve the conversion, isolate the product and calculate your yield as a percentage of the theoretical yield.
Carry out the experiment

Calculate your percentage yield
Show the product to your teacher.

Results: ____

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Conclusion: ____

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29

Chem Prac 1

Topics: Making Compounds Chemical reactions

Aim: To prepare magnesium sulfate heptahydrate from magnesium carbonate.

Equipment

Balance
Beaker, 100ml
Stirring Rod
Measuring Cylinder, 100ml
Filter funnel and paper
Retort stand & ring clamp
Evaporating Basin
Bunsen, tripod, gauze
Sulfuric acid ,1M (5.4%)
Magnesium Carbonate
Distilled water

Procedure

Weigh 2g of magnesium carbonate.
Write an equation for the conversion of magnesium carbonate to magnesium sulfate.
Calculate the quantity of reagents required for 2g of the carbonate.
Draw a flow diagram showing how you would use the equipment to achieve the conversion, isolate the product and calculate your yield as a percentage of the theoretical yield.
Carry out the experiment.

Calculate your percentage yield.
Show the product to your teacher.

Result:

Conclusion:

Risk Level: Mild Hazard: Beware of flying crystal fragments and "Bumping" when boiling solutions to small volumes. Wear safety glasses. Sulfuric acid (1M) is corrosive and any skin contact should be treated with vigorous washing

STUDENT:________________

30

Chem Prac 2

Aim: To prepare copper carbonate from copper sulfate though hydroxide and chloride stages.

Equipment

Balance, 0.01g accuracy
Bunsen, tripod, gauze
Beaker, 250ml
Stirring rod
Copper Sulfate
Sodium Hydroxide,2M(8%)
Hydrochloric acid, 2M,20%
Distilled water
Sodium Carbonate
Evaporating basin
Filter funnel
Conical flask

Procedure

Weigh out 2.49g of copper sulfate pentahydrate in the beaker.
Dissolve in 20ml of distilled water.
Calculate the moles of copper sulfate present.
Write an equation for the conversion to copper hydroxide.
Calculate the volume of sodium hydroxide 2M required.
Record any changes when the hydroxide is added.
Write an equation for the neutralisation of the hydroxide with hydrochloric acid.
What volume of 2M acid will be required?

Record any changes in the solution when the acid is added
Write an equation for the conversion of the chloride to a carbonate.
Calculate the quantity of sodium carbonate required.
Note any changes when the carbonate is added.
Weigh a filter paper.
Collect the precipitate by filtration.
Wash with 10ml of distilled water.
Place the paper in an evaporating basin and heat gently with a bunsen until dry.
Weigh the precipitate.
Calculate the moles of copper carbonate recovered.
Calculate this yield as a percentage of the moles of original copper sulfate.

Results: ____

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Conclusion: ____

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30

Chem Prac 2

Topics: Chemical Reactions Mole Concept

Aim: To prepare copper carbonate from copper sulfate though hydroxide and chloride stages.

Equipment

Balance, 0.01g accuracy
Bunsen, tripod, gauze
Beaker, 250ml
Stirring rod
Copper Sulfate
Sodium Hydroxide,2M(8%)
Hydrochloric acid, 2M,20%
Distilled water
Sodium Carbonate
Evaporating basin
Filter funnel
Conical flask

Procedure

Weigh out 2.49g of copper sulfate pentahydrate in the beaker.
Dissolve in 20ml of distilled water.
Calculate the moles of copper sulfate present.
Write an equation for the conversion to copper hydroxide.
Calculate the volume of sodium hydroxide 2M required.
Record any changes when the hydroxide is added.
Write an equation for the neutralisation of the hydroxide with hydrochloric acid.
What volume of 2M acid will be required?

Record any changes in the solution when the acid is added
Write an equation for the conversion of the chloride to a carbonate.
Calculate the quantity of sodium Carbonate required.
Note any changes when the carbonate is added.
Weigh a filter paper.
Collect the precipitate by filtration.
Wash with 10ml of distilled water.
Place the paper in an evaporating basin and heat gently with a bunsen until dry.
Weigh the precipitate.
Calculate the moles of copper carbonate recovered.
Calculate this yield as a percentage of the moles of original copper sulfate.

Result: Reaction with hydroxide produces a light blue gel. Reaction with the acid produces a green solution. Conversion to carbonate yields a green precipitate.

Conclusion: Over heating in the final stage will burn the paper and convert the carbonate to copper oxide (black). Filtration is time consuming. This practical may require 2 hours.

Risk Level: Moderate Hazard: Sodium hydroxide 2M is caustic and hydrochloric acid is corrosive. Any skin contact with the reagents should be treated with vigorous washing.

STUDENT:________________

31 Chemical Energy

Aim: To measure the energy produced in a reaction.

Equipment

Polystyrene Cup
Measuring Cylinder
Thermometer
Hydrochloric Acid, 1M, 10%
Sodium Hydroxide, 1M, 4%

Procedure

Measure 50ml of the acid into the polystyrene cup.
Record its temperature.
Add 50ml of sodium hydroxide solution.
Stir briefly with the thermometer and measure the maximum temperature reached.

Energy Yield = Mass of Soln X Specific Heat X Temp Change

= 0.1 X 4,180 X Temp Change in degrees Celsius

= ______ Joules

Molar Yield = Energy / 0.05 Mole

= ________ Joules/ Mole

Results: ____

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Conclusion: ____

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31

Chemical Energy

Topics: Chemical Energy Chemical Reactions

Aim: To measure the energy produced in a reaction.

Equipment

Polystyrene Cup
Measuring Cylinder
Thermometer
Hydrochloric Acid, 1M, 10%
Sodium Hydroxide, 1M ,4%

Procedure

Measure 50ml of the acid into the polystyrene cup.
Record its temperature.
Add 50ml of sodium hydroxide solution.
Stir briefly with the thermometer and measure the maximum temperature reached.

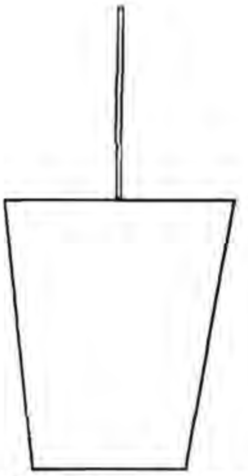
Energy Yield = Mass of Soln X Specific Heat X Temp Change

= 0.1 X 4,180 X Temp Change in degrees Celsius

= ______ Joules

Molar Yield = Energy / 0.05 Mole

= ________ Joules/ Mole



Result: The theoretical yield is 56.1kjoules per mole for this reaction, or 2,800 Joules for 0.05M or an expected temperature change of 6.7 degrees.

Conclusion:

Risk Level: Moderate Hazard: Hydrochloric acid 1M is corrosive and sodium hydroxide 1M is caustic. Any skin contact with either chemical should be treated immediately with vigorous washing with water.

STUDENT:________________

32 Chlorine

Aim: To produce chlorine gas and observe some of its properties.

Equipment

Conc Hydrochloric Acid
Manganese Dioxide
Test tubes, large , three
Stoppers and glass tubing (bent for delivery of gas)
Tongs
Rubber gloves
Universal Indicator
Test tube rack
wax paper
steel wool
Magnesium ribbon
Gas Jars, two
Sodium Bromide (or Iodide) solution 0.1M (1%)

Procedure

TEACHER DEMONSTRATION ONLY TO BE PERFORMED IN A FUME HOOD.

In the space below, record what happens during each stage of the demonstration.

Results: ____

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Conclusion: ____

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32

Chlorine

Topics: Matter Elements

Aim: To produce chlorine gas and observe some of its properties.

Equipment

Conc Hydrochloric Acid
Manganese Dioxide
Test tubes, large , three
Stoppers and glass tubing (bent for delivery of gas)
Tongs
Rubber gloves
Universal Indicator
Test tube rack
wax paper
steel wool
Magnesium ribbon
Gas Jars, two
Sodium Bromide (or Iodide) solution 0.1M (1%)

Procedure

TEACHER DEMONSTRATION ONLY TO BE PERFORMED IN A FUME HOOD. WEAR GLOVES.
Add about 3g of magnesium dioxide to a test tube.
Add concentrated hydrochloric acid to a depth of 3cm.
Fit the rubber stopper and delivery tube.
Heat gently until until a yellow gas is produced.
Collect the gas into a clean dry test tube.
Add a small wad of burning wax paper to the gas.
Collect gas into a gas jar.
Insert a small wad of steel wool on a deflagrating spoon.

Collect gas into a second gas jar.
This time insert a small piece of magnesium on the deflagrating spoon.
Produce more gas, this time bubbling into a test tube containing about 5cm of water.
Test the water with Universal indicator.
Bubble some of the gas into a solution of sodium bromide.

Result: Chlorine is a heavy yellow gas which reacts strongly with metals. In water the gas produces acid and will produce ionic reactions with other salts.

Conclusion: Chlorine gas is a powerfully reactive Halogen gas

Risk Level: EXTREMELY HAZARDOUS: EXPERIENCED TEACHER DEMONSTRATION ONLY. TO BE CARRIED OUT IN A FUME HOOD. Chlorine gas is powerfully corrosive attacking skin, eyes and lungs, any contact to be treated with vigorous washing and medical assistance. Concentrated hydrochloric acid is extremely corrosive and produces corrosive vapours. Any contact to be treated with vigorous washing and medical assistance.

STUDENT:________________

33 Chlorophyll Types

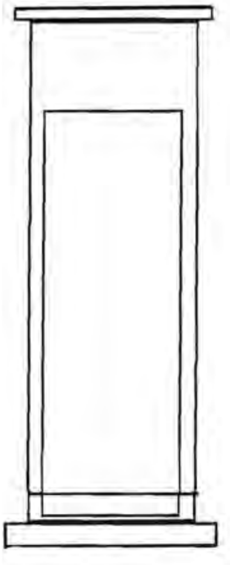
Aim: To separate the different photosynthetic pigments found in plant leaves.

Equipment

Mortar and pestle
Leaves (variegated Coleus recommended)
Methylated Spirits
Gas Jar
Chromatography paper

Procedure

Grind several leaves in a mortar with 20ml of methylated spirits.
Pour the liquid into a gas jar.
Add methylated spirits to achieve a depth of 1-2 cm.
Insert a sheet of chromatography paper so it stands vertically in the mixture but does not touch the sides.
Leave for at least 1hr in a fume hood.
Remove and allow to air dry.
Draw the result on the diagram below.



Results: ____

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Conclusion: ____

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33

Chlorophyll Types

Topics: Energy in Life Plants

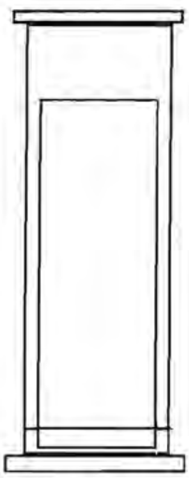
Aim: To separate the different photosynthetic pigments found in plant leaves.

Equipment

Mortar and pestle
Leaves (variegated Coleus recommended)
Methylated Spirits
Gas Jar
Chromatography paper

Procedure

Grind several leaves in a mortar with 20ml of methylated spirits.
Pour the liquid into a gas jar.
Add methylated spirits to achieve a depth of 1-2 cm.
Insert a sheet of chromatography paper so it stands vertically in the mixture but does not touch the sides.
Leave for at least 1hr in a fume hood.
Remove and allow to air dry.



Result: Several bands of pigment formed on the paper.

Conclusion: In addition to Chlorophyll A an B most plants also contain various Xanthophylls.

Risk Level: Mild Hazard: Methylated spirits is inflammable and must be isolated from flames. The fumes may irritate asthmatics and use of a fume hood is recommended.

STUDENT:________________

34 Chromatography

Aim: To separate a variety of dissolved substances on the basis of the size of their molecules.

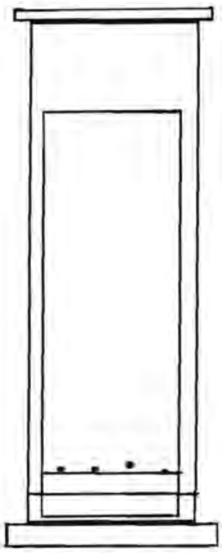
Equipment

Chromatography or filter paper cut into rectangles 4cm by 15cm
250ml beaker

Procedure

Draw a line in pencil 2cm from the bottom of the paper.
At even spaces along the line make four dots with felt tip pens: black, purple, green and red.
Fill the beaker to a depth of 1cm with water.
Stand the paper in the beaker, pen dots toward the water.
Allow the paper to absorb water for about 20mins.
Draw the result on the diagram below.

The paper sheets can be dried and pasted into student work books.



Results: ____

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Conclusion: ____

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34 Chromatography

Topics: Matter Separating

Aim: To separate a variety of dissolved substances on the basis of the size of their molecules.

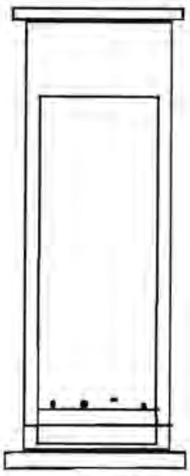
Equipment

Chromatography or filter paper cut into rectangles 4cm by 15cm
250ml beaker

Procedure

Draw a line in pencil 2cm from the bottom of the paper.
At even spaces along the line make four dots with felt tip pens: black, purple, green and red.
Fill the beaker to a depth of 1cm with water.
Stand the paper in the beaker, pen dots toward the water.
Allow the paper to absorb water for about 20mins.

The paper sheets can be dried and pasted into student work books.



Result: As capillary action draws water up the paper the component dyes in the inks will be separated into bands.

Conclusion: Inks contain various dyes, each with molecules of different sizes. The different sized molecules will move at different rates through the paper and so become separated into bands.

Risk Level: Very Low Hazard

STUDENT:________________

35 Chromosomes

Aim: To observe chromosomes in stages of mitotic division.

Equipment

Garlic (or onion) shoot tips
Fixer (3:1 Methanol, Glacial Acetic acid)
Microscope slides
Coverslips
Compound Microscope
Stain (1gm Orcein dissolved in 45mls glacial Acetic acid then diluted with 55mls distilled water)

Procedure

Harvest shoot tips before dawn and drop into the fixer.
Squash the tips onto slides.
Flood the slides with stain and leave for 1hour.
Gently rinse with water.
Mount with a coverslip.
Examine under the microscope at 400X.
In the space below, draw some of the chromosome groups you see.

Results: ______________________________

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Conclusion: ______________________________

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35 Chromosomes

Topics: Genetics Reproduction

Aim: To observe chromosomes in stages of mitotic division.

Equipment

Garlic (or onion) shoot tips
Fixer (3:1 Methanol, Glacial Acetic acid)
Microscope slides
Coverslips
Compound Microscope
Stain (1gm Orcein dissolved in 45mls glacial Acetic acid then diluted with 55mls distilled water)

Procedure

Harvest shoot tips before dawn and drop into the fixer.
Squash the tips onto slides.
Flood the slides with stain and leave for 1hour.
Gently rinse with water.
Mount with a coverslip.
Examine under the microscope at 400X.

Result: Chromosomes are seen in various stages of mitotic division, particularly metaphase.

Conclusion:

Risk Level: HAZARDOUS: Glacial acetic acid is highly corrosive and produces noxious fumes. Methanol is inflammable and must be kept from flames. The fixative and stain should only be handled by the teacher.

STUDENT:________________

36 Closed Resonance Pipes

Aim: To determine the speed of sound from tuning fork resonance.

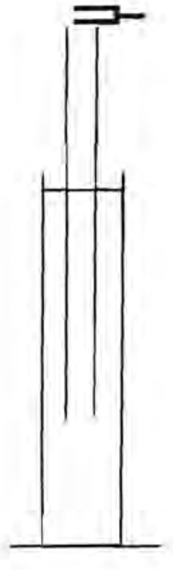
Equipment

Tuning fork, C 256 Hertz
Glass tube,2cm diam, 0.6m long
Metre Rule
Large Measuring Cylinder

Procedure

Fill the measuring cylinder with water.
Rest the glass tube inside the cylinder.
Strike the tuning fork and hold it over the mouth of the tube.
Slowly draw the tube upward.
Whenever a sudden increase in sound volume is heard, record the length of glass tube extending from the water.

Since $f = nv/4l$, then $256 = nv/4l$, therefore for $n = 1$, $v = 64l$ where 'l' is the length of the air column.



Results: ______________________________

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Conclusion: ______________________________

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36

Closed Resonance Pipes

Topics: Waves

Aim: To determine the speed of sound from tuning fork resonance.

Equipment

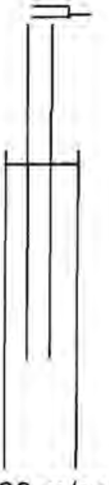
Tuning fork, C 256 Hertz
Glass tube,2cm diam, 0.6m long
Metre Rule
Large Measuring Cylinder

Procedure

Fill the measuring cylinder with water.
Rest the glass tube inside the cylinder.
Strike the tuning fork and hold it over the mouth of the tube.
Slowly draw the tube upward.
Whenever a sudden increase in sound volume is heard, record the length of glass tube extending from the water.

Since f =nv/4*l*, then 256 = nv/4*l* , therefore for n = 1, v= 64/*l*
where '*l*' is the length of the air column.

Hint: n = 1, 0.194m
n = 3, 0.582m odd harmonics only.
Ignore semi tones.



Result: The speed of sound in air is 330 m/sec

Conclusion: Harmonics in closed pipes give a more accurate measure of the speed of sound than stop watch measurements of distant events.

Risk Level: Low Hazard

STUDENT:________________

37 Coat Hanger Bell

Aim: To demonstrate that sound travels better in solids than in air.

Equipment

Metal Coat Hangar
String

Procedure

Tie about 70cm of string to each arm of a coat hanger.
The subject presses the end of each string into their ears then leans forward so the hangar is free of the body.
Strike the hangar with a pen.
Draw the apparatus in the space below and explain what happened.

Results: ____

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Conclusion: ____

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37

Coat Hanger Bell

Topics: Waves

Aim: To demonstrate that sound travels better in solids than in air.

Equipment

Metal Coat Hangar

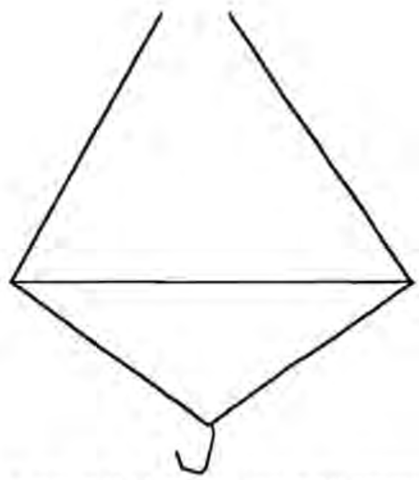
String

Procedure

Tie about 70cm of string to each arm of a coat hanger.

The subject presses the end of each string into their ears then leans forward so the hangar is free of the body.

Strike the hangar with a pen.



Result: The subject hears a sound like a huge bell transmitted through the metal and string while onlookers hear only a faint sound.

Conclusion: Sound travels better in dense materials such as string and metal compared to air.

Risk Level: Low Hazard

STUDENT:________________

38 Cobalt Equilibria

Aim: To demonstrate that a chemical reaction forms an equilibrium which may proceed in either direction depending on the concentration of reactants.

Equipment

Cobalt Chloride
Conc Hydrochloric Acid
2- Propanol
Silver Nitrate
Beakers, 3

Procedure

Soln A: 1g cobalt chloride in 10ml propanol. Add distilled water drop wise until the solution just turns pink.
Soln B: 10g cobalt chloride in 20ml water.
Prepare 20ml, 0.1M silver nitrate.
1.Heat solution A and observe any changes. Allow to cool.
2.Add about 10ml of conc. hydrochloric acid to solution B in a fume hood.
Add silver nitrate solution.

Results: ____

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Conclusion: ____

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38

Cobalt Equilibria

Topics: Equilibrium Chemical Reactions

Aim: To demonstrate that a chemical reaction forms an equilibrium which may proceed in either direction depending on the concentration of reactants.

Equipment

Cobalt Chloride
Conc Hydrochloric Acid
2- Propanol
Silver Nitrate
Beakers, 3

Procedure

Soln A: 1g cobalt chloride in 10ml propanol. Add distilled water drop wise until the solution just turns pink.
Soln B: 10g cobalt chloride in 20ml water.
Prepare 20ml, 0.1M silver nitrate.
1.Heat solution A and observe any changes. Allow to cool.
2.Add about 10ml of conc. hydrochloric acid to solution B in a fume hood.
Add silver nitrate solution.

Result: Heating drives the reaction to the blue ion, while cooling reverses the reaction. Adding HCl drives the reaction to to the blue ion while adding silver chloride reverses the reaction.

Conclusion: $Co(H_2O)_6^{2+}$ + $4Cl^-$ <> $CoCl_4^{2-}$ + H_2O The reaction is driven to the right by adding energy or chlorine ions, but driven to the left by removing energy or chlorine ions or adding excess water.

Risk Level: HAZARDOUS: Concentrated hydrochloric acid is extremely corrosive and releases toxic fumes. This reagent should only be opened in a fume hood and only handled by a teacher wearing gloves. Cobalt chloride is toxic if ingested may be carcinogenic. Silver nitrate is toxic and stains the skin. Propanol is inflammable and should be isolated from flames or oxidising agents.

STUDENT:________________

39 Code of Life

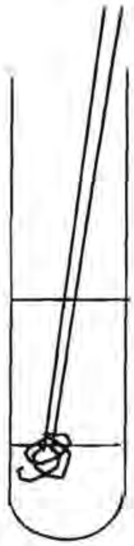
Aim: To extract visible strands of DNA from organic material.

Equipment

Dried Peas 1g(ground in a mortar or coffee grinder) stirred for 1 hr in Buffer 2.
Buffer 1: Disodium hydrogen phosphate 810ml, 10mM, 0.358% plus sodium dihydrogen phosphate 190ml, 10mM, 0.156%, add magnesium chloride 2g.
Buffer 2: As above with sodium chloride added to 1.2%.
Sodium Lauryl Sulphate1%
Centrifuge,Test Tube, Ethanol, cotton gauze, Ice beaker, Pasteur pipettes

Procedure

Filter 10ml of the ground pea suspension through cotton gauze.
Pour into a centrifge tube and spin to a pellet.
Discard the SUPERNATANT containing soluble proteins.
Resuspend the pellet in 10ml Buffer 1.
Centrifuge again and discard supernatant.
Add 4ml of sodium lauryl sulfate 1% and stir until all the lumps are removed.
Centrifuge to a pellet.
Use a pasteur pipette to carefully draw off 2ml of the supernatant into a clean test tube.
Slowly layer 3ml of ice cold ethanol on top of the separated supernatant.
Use a pasteur pipette to slowly stir the ethanol/ supernatant interface.



Results: ____

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Conclusion: ____

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39

Code of Life

Topics: Genetics Reproduction

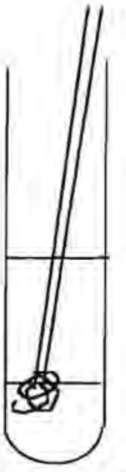
Aim: To extract visible strands of DNA from organic material.

Equipment

Dried Peas 1g(ground in a mortar or coffee grinder) stirred for 1 hr in Buffer 2.
Buffer 1: Disodium hydrogen phosphate 810ml, 10mM, 0.358% plus sodium dihydrogen phosphate 190ml, 10mM, 0.156%, add magnesium chloride 2g.
Buffer 2: As above with sodium chloride added to 1.2%.
Sodium Lauryl Sulphate1%
Centrifuge,Test Tube, Ethanol, cotton gauze, Ice beaker, Pasteur pipettes

Procedure

Filter 10ml of the ground pea suspension through cotton gauze.
Pour into a centrifge tube and spin to a pellet.
Discard the SUPERNATANT containing soluble proteins.
Resuspend the pellet in 10ml Buffer 1.
Centrifuge again and discard supernatant.
Add 4ml of sodium Lauryl Sulfate 1% and stir until all the lumps are removed.
Centrifuge to a pellet.
Use a pasteur pipette to carefully draw off 2ml of the supernatant into a clean test tube.
Slowly layer 3ml of ice cold ethanol on top of the separated supernatant.
Use a pasteur pipette to slowly stir the ethanol/ supernatant interface.



Result: Long translucent strands will wind around the pipette.

Conclusion: DNA is a sizeable component of all biological material and can be extracted with relatively simple methods. You may wish to tell your students that the information coded on their small DNA sample is several million times that stored on a PC hard drive.

Risk Level: Mild Hazard: Ethanol is flammable and must be separated from all naked flames.

STUDENT:________________

40 Collisions 1

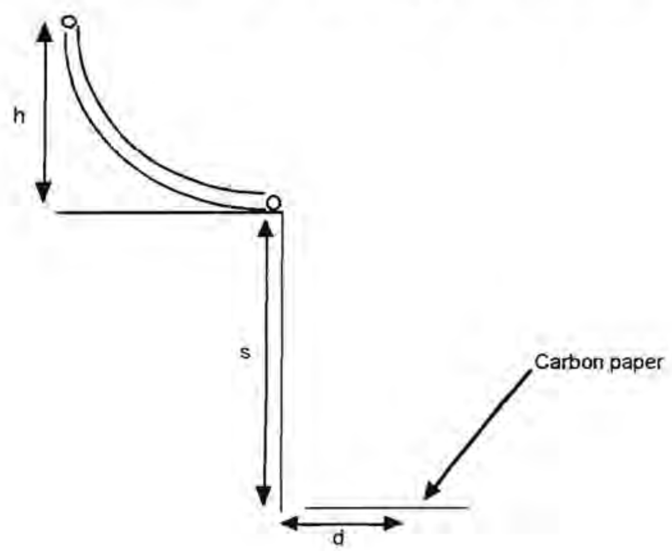
Aim: To observe and analyse collisions in one or two dimensions.

Equipment

Soft walled 3/4" poly pipe
Retort stand, clamp
Metre rule
Carbon paper
Marbles
Balance, 0.1g accuracy

Procedure

Mount the curved poly pipe in a retort stand so that marbles rolled down the tube are delivered to the edge of the bench.
Measure the height of the tube above the bench.
Measure the height of the bench.
Place carbon paper on the floor directly below the tube.
Weigh two marbles.
Carefully place a marble at the lower mouth of the tube.
Release the other marble into the upper mouth of the tube.
Use the impressions on the carbon paper to measure how far each marble travelled horizontally after the collision before hitting the floor.
Calculate the impact velocity of the upper marble from:
$PE = mgh = KE \text{ gained} = 1/2mv^2$
From this, derive the momentum of the upper marble.
Calculate the time to fall from the table to the floor.
$s = ut + 1/2\ at^2$, where $u = 0$, s = height of table.
Calculate the velocities and hence the momentum of the marbles after the collision using the carbon paper records
$v = d/t$ where d = impact distance from the bench.



Results: ________________________________

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Conclusion: ________________________________

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Collisions 1

Topics: Momentum

Aim: To observe and analyse collisions in one or two dimensions.

Equipment

Soft walled 3/4" poly pipe
Retort stand, clamp
Metre rule
Carbon paper
Marbles
Balance, 0.1g accuracy

Procedure

Mount the curved poly pipe in a retort stand so that marbles rolled down the tube are delivered to the edge of the bench.
Measure the height of the tube above the bench.
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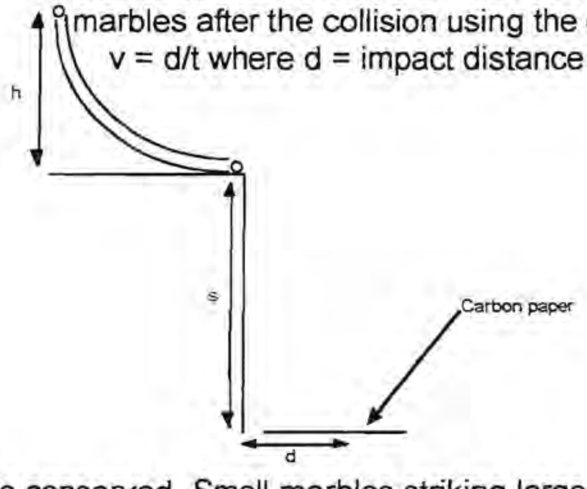
Place carbon paper on the floor directly below the tube.
Weigh two marbles.
Carefully place a marble at the lower mouth of the tube.
Release the other marble into the upper mouth of the tube.
Use the impressions on the carbon paper to measure how far each marble travelled horizontally after the collision before hitting the floor.
Calculate the impact velocity of the upper marble from:
PE = mgh = KE gained = $1/2mv^2$
From this, derive the momentum of the upper marble.
Calculate the time to fall from the table to the floor.
$s = ut + 1/2\ at^2$, where $u = 0$, s = height of table.
Calculate the velocities and hence the momentum of the marbles after the collision using the carbon paper records
$v = d/t$ where d = impact distance from the bench.



Result: Momentum is conserved. Small marbles striking large ones impart little velocity. Large marbles hitting small marbles impart larger velocities.

Conclusion: Marbles falling through the fixed height of the tube have the same velocity but different momentum depending on their mass. (Hint: for two dimensional collisions the target marble may be offset from the exit mouth of the tube. However it will be necessary to cut the exit mouth open at the sides to allow free vector changes and to also record offset distances on the carbon paper.

Risk Level: Low Hazard

STUDENT:________________

41 Colorimetry

Aim: To quantitatively examine the function of an enzyme.

Equipment

sodium chloride, 0.9%
Methylene Blue,0.1%, pH 7
Ice and tray
Mortar and Pestle
Test tubes, 6
Measuring Cylinder
Simple Colorimeter
(photoresistor in a dark box with a constant light source shining through a test tube apperture)
Multimeter
Filter funnel and paper
beakers,250ml, 2
Fresh Mouse Liver
Hydrochloric acid 1M, 10%
Sodium Hydroxide 1M, 4%

Procedure

Prepare a 1 in 2 dilution sequence of the methylene blue in saline through ten steps.
Connect the colorimeter to the DC power supply.
Connect the multimeter to the colorimeter and adjust to the millivolt range.
Place each dye dilution in the colorimeter and record the voltage on the multimeter.
Prepare a graph of dye concentration versus voltage.
Place the Mortar and pestle in an ice bath.
Place the freshly harvested liver tissue in the mortar and grind with 50ml of the saline.
Pour the fluid into a filter draining into a test tube in the ice bath.
Place 6ml of a mid range dilution of the dye into each of 5 test tubes .
Add 1ml of 1M hydrochloric acid to one tube.
Add 1ml of 1M sodium hydroxide to another tube.
Add 1ml of saline to the remaining tubes.
Add 1ml of liver extract to each tube.
Place the acid, base and one saline tube in a beaker of water at 30 degrees.
Place one tube in a beaker of water at 15 degrees.
Place one tube in a beaker of water at 60 degrees.
Leave one tube in the ice. Read all tubes after 5 minutes.

Results: ____

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Conclusion: ____

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41

Colorimetry

Topics: Biological Chemistry Energy in Life

Aim: To quantitatively examine the function of an enzyme.

Equipment

sodium chloride, 0.9%
Methylene Blue,0.1%, pH 7
Ice and tray
Mortar and Pestle
Test tubes, 6
Measuring Cylinder
Simple Colorimeter
(photoresistor in a dark box with a constant light source shining through a test tube apperture)
Multimeter
Filter funnel and paper
beakers,250ml, 2
Fresh Mouse Liver
Hydrochloric acid 1M, 10%
Sodium Hydroxide 1M, 4%

Procedure

Prepare a 1 in 2 dilution sequence of the methylene blue in saline through ten steps.
Connect the colorimeter to the DC power supply.
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Add 1ml of saline to the remaining tubes.
Add 1ml of liver extract to each tube.
Place the acid, base and one saline tube in a beaker of water at 30 degrees.
Place one tube in a beaker of water at 15 degrees.
Place one tube in a beaker of water at 60 degrees.
Leave one tube in the ice. Read all tubes after 5 minutes.

Result: The liver extract decolourised the dye. The most active tube was saline at 30 degrees followed by saline at 15 degrees. All other tubes showed minimal activity.

Conclusion: Liver contains an enzyme which oxidises Methylene Blue into a colourless form. Enzyme activity is very sensitive to temperature and pH. The enzyme was irreversibly denatured in the acid, base and 60 degree saline. Activity at 15 degrees was approximately half that at 30 degrees.

Risk Level: Low Hazard;

STUDENT:________________

42 Coloured Fire

Aim: To release the chemical energy stored in sugar and observe the flame spectrum of several elements.

Equipment

Pure Icing Sugar
Potassium Nitrate
Strontium Chloride
Sodium Chloride
Copper Chloride
Mortar and Pestles
Heat Tiles

Procedure

Samples of strontium chloride, sodium chloride and copper chloride are ground in SEPARATE mortar and pestles.
20g of icing sugar and 20g of potassium nitrate are mixed by the teacher in a fourth mortar and pestle.
Take a spatula of the nitrate/sugar mixture on to a heat tile.
A small sample of one of the strontium, sodium or copper chloride is sprinkled over the mixture.

IN THE FUME HOOD: The samples may be ignited by a taper.

Results: ________________________________

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Conclusion: ________________________________

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42 Coloured Fire

Topics: Matter Atoms & Molecules Energy In Life

Aim: To release the chemical energy stored in sugar and observe the flame spectrum of several elements.

Equipment

Pure Icing Sugar
Potassium Nitrate
Strontium Chloride
Sodium Chloride
Copper Chloride
Mortar and Pestles
Heat Tiles

Procedure

Samples of strontium chloride, sodium chloride and copper chloride are ground in SEPARATE mortar and pestles.
20g of icing sugar and 20g of potassium nitrate are mixed by the teacher in a fourth mortar and pestle.
Students take a spatula of the nitrate/sugar mixture on to a heat tile.
A small sample of one of the strontium, sodium or copper chloride is sprinkled over the mixture.

IN THE FUME HOOD: The samples may be ignited by a taper.

Result: Sugar burns powerfully with potassium nitrate. Added strontium produces a red flame, sodium a yellow flame and copper gives a green flame.

Conclusion: Sugar contains large quantities of chemical energy which can be released in a flaming chemical reaction with potassium nitrate. Different elements heated in this flame will produce different coloured emission spectra.

Risk Level: Moderate Hazard: FUME HOOD REQUIRED. Potassium nitrate is a powerful oxidising agent only to handled by the teacher, mix but DO NOT GRIND. Toxic fumes may result from the reaction. Close supervision of students is necessary.

STUDENT:________________

43 Convection

Aim: To observe convection currents in water.

Equipment	**Procedure**
Ice	Fill both beakers with water.
Beakers, 1 litre, two	Place a few crystals of permanganate in one beaker.
Tripods, two	Place both beakers on tripods.
Bunsen	Place some ice in the second beaker.
Potassium Permanganate	Place a few permanganate crystals on the ice.
	Begin heating the first beaker with a bunsen.
	In the space below, draw the current patterns observed in the beakers.

Results: ____

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Conclusion: ____

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43 Convection

Topics: Heat States of Matter Pressure/Density

Aim: To observe convection currents in water.

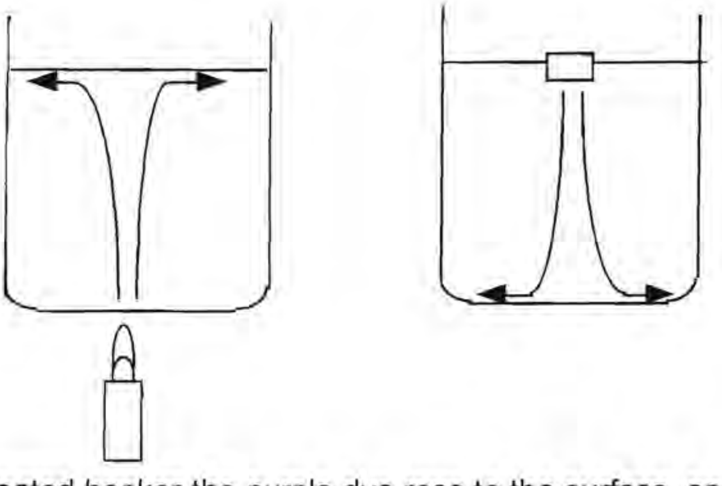
Equipment

Ice
Beakers, 1 litre, two
Tripods, two
Bunsen
Potassium Permanganate

Procedure

Fill both beakers with water.
Place a few crystals of permanganate in one beaker.
Place both beakers on tripods.
Place some ice in the second beaker.
Place a few permanganate crystals on the ice.
Begin heating the first beaker with a Bunsen.

A control for this experiment would be a beaker with permanganate but without ice or heating.



Result: In the heated beaker the purple dye rose to the surface, spread and settled at the sides. In the beaker with ice the dye fell to the bottom before spreading and rising at the sides.

Conclusion: When liquid is heated it expands, becoming less dense and so is displaced upwards by the denser surrounding liquid. At the surface the liquid cools as it spreads, contracting, becoming more dense and so begins to sink. In the beaker with ice the process is reversed.

Risk Level: Low Hazard: Potassium Permanganate is harmful if ingested and stains the skin.

STUDENT:________________

44 Copper Complexes

Aim: To observe the formation of various soluble ion complexes.

Equipment

Copper Sulfate
Salacylic Acid
Ammonia, 2M
Potassium Iodide
Tartaric Acid
EDTA
Hydrochloric Acid 1M, 10%

Procedure

Prepare 100ml of 1M copper sulfate solution.
Prepare 10ml, 10% solutions of the Salacylic Acid, Tartar and Iodide in test tubes. Add 10ml of the hydrochloric acid and Ammonia to separate test tubes. THE AMMONIA PREPARATION MUST STAY IN THE FUME CUPBOARD.
Add 10ml of copper sulfate solution to each test tube and mix.

Reactants	Colour

Results: ____

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Conclusion: ____

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44 Copper Complexes

Topics: Ions Chemical reactions

Aim: To observe the formation of various soluble ion complexes.

Equipment

Copper Sulfate
Salacylic Acid
Ammonia, 2M
Potassium Iodide
Tartaric Acid
EDTA
Hydrochloric Acid 1M, 10%

Procedure

Prepare 100ml of 1M copper sulfate solution.
Prepare 10ml, 10% solutions of the Salacylic Acid, Tartar and Iodide in test tubes. Add 10ml of the hydrochloric acid and Ammonia to separate test tubes. THE AMMONIA PREPARATION MUST STAY IN THE FUME CUPBOARD.
Add 10ml of copper sulfate solution to each test tube and mix.

Result: EDTA formed a deep blue solution, ammonia a dark blue solution, iodide a brown suspension, tartar a turquoise solution, salacylic acid a dark green solution, and hydrochloric acid a lime green suspension.

Conclusion: Copper sulfate in water forms a hexahydrate ion, while the other complexes are formed on addition of other ions.

Risk Level: HAZARDOUS: Recommended as a teacher demonstration or for senior students only. Ammonia produces caustic fumes damaging to the nose and airways. Salacylic acid is harmful if swallowed.

STUDENT:________________

45 Crystal Forms

Aim: To observe a variety of crystal shapes.

Equipment

Ammonium Chloride
Sodium Hydrogen Sulfate
Copper Sulfate
Watchglasses, four
Beakers, small, four
Busen,tripod,gauze
Dissecting Microscopes

Procedure

Measure 4g of each salt into separate beakers and add 10mls water.
Heat over a bunsen until the salts have dissolved.
Pour 2 ml of each solution into a watch glass and observe under the microscope.

Results: ____

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Conclusion: ____

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45

Crystal Forms

Topics: Matter

Aim: To observe a variety of crystal shapes.

Equipment

Ammonium Chloride
Sodium Hydrogen Sulfate
Copper Sulfate
Watchglasses, four
Beakers, small, four
Busen,tripod,gauze
Dissecting Microscopes

Procedure

Measure 4g of each salt into separate beakers and add 10mls water.
Heat over a Bunsen until the salts have dissolved.
Pour 2 ml of each solution into a watch glass and observe under the microscope.

Result: As the solutions cooled, crystals formed. The ammonium salt forming dendrites, the copper salt forming plates and the sodium salt forming needles.

Conclusion: Salt crystals form different geometric shapes depending on the the structure of their inter -molecular bonds.

Risk Level: Moderate Hazard: Copper sulfate is harmful by ingestion, skin contact or inhalation. Students should be warned not to touch the crystals.

STUDENT:________________

46 Crystal Forms 1

Aim: To examine the shapes of various crystals.

Equipment

Copper Sulfate
Magnesium Sulfate
Iron Sulfate
Alum
Watch glasses, four
Dissecting Microscopes,

Procedure

Place a spatula of each salt on a watch glass and examine under a dissecting microscope.
Draw the crystals you see.

Results: ________________________________

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Conclusion: ________________________________

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46

Crystal Forms 1

Topics: Matter Rocks and Minerals

Aim: To examine the shapes of various crystals.

Equipment

Copper Sulfate
Magnesium Sulfate
Iron Sulfate
Alum
Watch glasses, four
Dissecting Microscopes,

Procedure

Place a spatula of each salt on a watch glass and examine under a dissecting microscope.
Draw the crystals you see.

Result: Each crystal had a different shape, size and colour.

Conclusion: The properties of crystals are dependent on the forces between molecules which determine the crystal lattice.

Risk Level: Low Hazard

STUDENT:________________

47 Crystal Garden

Aim: To make silicate crystals from various soluble seed compounds.

Equipment

Alum
Ferrous Sulfate
Magnesium Sulfate
Manganese Sulfate
Sodium Silicate solution (Waterglass)
Beaker, 250ml
Spatulas, four

Procedure

Dilute 20ml sodium silicate with 100ml water in the beaker and stir.
Allow the solution to settle for a few minutes.
Add a few crystals of each of the other salts and observe over the next hour or overnight.
Draw the result.

Results: ________________________________

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Conclusion: ________________________________

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47 Crystal Garden

Topics: Matter Solubility

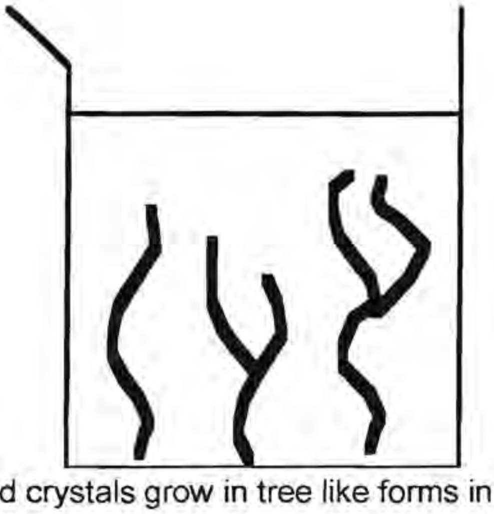
Aim: To make silicate crystals from various soluble seed compounds.

Equipment

Alum
Ferrous Sulfate
Magnesium Sulfate
Manganese Sulfate
Sodium Silicate solution (Waterglass)
Beaker, 250ml
Spatulas, four

Procedure

Dilute 20ml sodium silicate with 100ml water in the beaker and stir.
Allow the solution to settle for a few minutes.
Add a few crystals of each of the other salts and observe over the next hour or overnight.
Draw the result.



Result: Different coloured crystals grow in tree like forms in the the liquid.

Conclusion: The metal salts added form insoluble silicate crystals by reacting with the sodium silicate ($Na_2Si\ O_4$).

Risk Level: Low Hazard: All reagents are of low toxicity and only normal precautions should be taken. Students should not handle the crystals.

STUDENT:________________

48 Crystal Set

Aim: To make a very simple radio receiver.

Equipment

Earphone
Rectifier or diode
connecting wires, 3
Alligator clips, 5

Procedure

Connect a tap to an earphone lead using alligator clips.
Connect the other earphone lead to the diode.
Connect the other side of the diode to a long wire.
Listen to the earphone while sending a signal with a spark transmitter (see Radio Waves).
In the space below, draw the circuit you have made.

Results: ____

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Conclusion: ____

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48

Crystal Set

Topics: Electricity

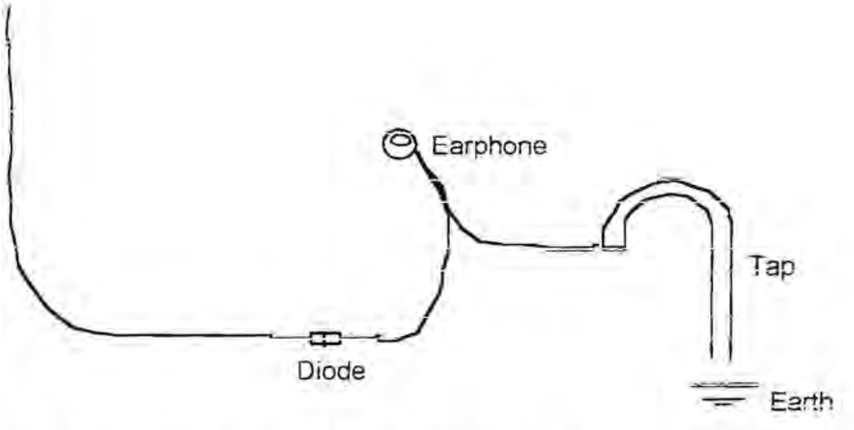
Aim: To make a very simple radio receiver.

Equipment

Earphone
Rectifier or diode
connecting wires, 3
Alligator clips, 5

Procedure

Connect a tap to an earphone lead using alligator clips.
Connect the other earphone lead to the diode.
Connect the other side of the diode to a long wire.
Listen to the earphone while sending a signal with a spark transmitter (see Radio Waves).



Result: Bursts of static are heard when the spark transmitter is used.

Conclusion: The crystal radio is a simple audio receiver of radio waves.

Risk Level: Low Hazard

STUDENT:________________

49 Crystal Size

Aim: To determine the effect of cooling rate on the formation of crystals.

Equipment

Beakers, 200ml, two
Test Tubes, two
Phenyl Salacylate
Filter paper
Bunsen and tripod

Procedure

Add 100ml of water to each beaker.
Add a spatula of phenyl salacylate to each test tube.
Place both tubes in one beaker of water.
Heat the beaker until the salacylate melts.
Turn off the Bunsen.
Transfer one test tube to the cold water beaker.
When both test tubes of salacylate have solidified examine the crystals closely on filter paper.

Results: ____

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Conclusion: ____

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49

Crystal Size

Topics: Quakes & Volcanoes Igneous Rocks

Aim: To determine the effect of cooling rate on the formation of crystals.

Equipment

Beakers, 200ml, two
Test Tubes, two
Phenyl Salacylate
Filter paper
Bunsen and tripod

Procedure

Add 100ml of water to each beaker.
Add a spatula of phenyl salacylate to each test tube.
Place both tubes in one beaker of water.
Heat the beaker until the salacylate melts.
Turn off the Bunsen.
Transfer one test tube to the cold water beaker.
When both test tubes of salacylate have solidified examine the crystals closely on filter paper.

Result: The crystals from the beaker of cold water formed quickly and were much smaller than the crystals which formed slowly in the hot water.

Conclusion: Minerals which are cooled slowly will form large crystals while minerals which cool rapidly have small crystals. Granite has large crystals (cooled slowly underground) while basalt has small crystals (cooled rapidly as larva flows).

Risk Level: Mild Hazard; Students should not touch the crystals directly or heat the Phenyl Salacylate directly in a Bunsen flame.

STUDENT: ____________________

50 Current balance

Aim: To measure the strength of a magnetic field produced in air cored solenoid.

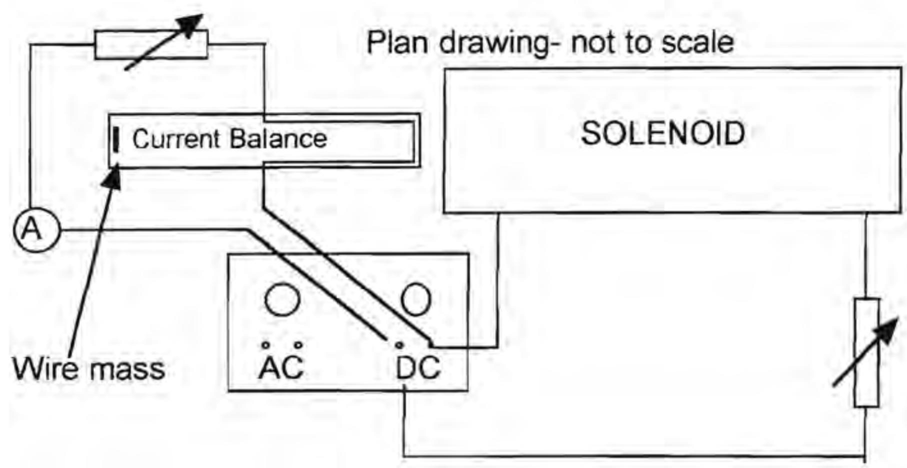
Equipment

Power Supply, 12V, DC,2
Variable Resistors,2
Ammeters
Current Balance
Retort stand, clamps
connecting wires
Balance (0.001g)
1cm lengths of copper wire
Air core solenoid

Procedure

Connect the solenoid, one ammeter, variable resistor and power supply in one circuit.
Use the retort stand to support the current balance so that it can pivot freely but with one end in the solenoid.
Via the pivots, connect the current balance in a second series circuit with an ammeter, variable resistor and the power supply.
Adjust the polarity of one circuit if the current balance is deflected upwards in the solenoid.

Weigh a 1cm length of wire and place it on the opposite end of the current balance.
Adjust the variable resistors until the magnetic force balances the weight of the wire.
Record the current in the balance circuit. I = _______
$F = BIl = mg$, where l = length of current balance wire perpendicular to the solenoid axis, $g = 9.8$ and
m = mass of cut wire.



Results: ____

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Conclusion: ____

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50

Current balance

Topics: Electromagnetism

Aim: To measure the strength of a magnetic field produced in air cored solenoid.

Equipment

Power Supply, 12V, DC,2
Variable Resistors,2
Ammeters
Current Balance
Retort stand, clamps
connecting wires
Balance (0.001g)
1cm lengths of copper wire
Air core solenoid

Procedure

Connect the solenoid, one ammeter, variable resistor and power supply in one circuit.
Use the retort stand to support the current balance so that it can pivot freely but with one end in the solenoid.
Via the pivots, connect the current balance in a second series circuit with an ammeter, variable resistor and the power supply.
Adjust the polarity of one circuit if the current balance is deflected upwards in the solenoid.

Weigh a 1cm length of wire and place it on the opposite end of the current balance.
Adjust the variable resistors until the magnetic force balances the weight of the wire.
$F = BIl = mg$, where l = length of current balance wire perpendicular to the solenoid axis.

Result: Since the length of the conductor, current, mass and acceleration due to gravity are constant, then the magnetic field strength 'B' can be calculated.

Conclusion: The sources of error in this experiment include friction in the current balance pivot and whether the pivot is accurately perpendicular to the ground.

Risk Level: Low Hazard

STUDENT:________________

51 Dicks Bug

Aim: To build an electronic bugging device.

Equipment

Fine gas jet soldering pen
"Dick Smith" Mini FM Transmitter, Code K5006 $20.
Match Box
FM Radio
Fluxed solder

Procedure

This device uses simple solid state components on a small printed circuit board. Construction takes about an hour and a half.

The device fits in a match box and really fires the imagination of jaded senior students.

Construction requires some soldering skill and the students should practice on some wire first.

Results: ____

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Conclusion: ____

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51

Dicks Bug

Topics: Electricity Electronics

Aim: To build an electronic bugging device.

Equipment

Fine gas jet soldering pen
"Dick Smith" Mini FM Transmitter, Code K5006 $20.
Match Box
FM Radio
Fluxed solder

Procedure

This device uses simple solid state components on a small printed circuit board. Construction takes about an hour and a half.
The device fits in a match box and really fires the imagination of jaded senior students.
Construction requires some soldering skill and the students should practice on some wire first.

Result: The device easily transmits from several classrooms away say 30m. Speaking directly to the bug overloads the transducer microphone which is much better at detecting subdued sound.

Conclusion: A simple, two transistor amplifier circuit boosts signal interrupts from the transducer microphone. The amplified signals then frequency modulate a carrier signal created by a simple copper coil feedback loop.

Risk Level: Low Hazard: Except to your career if you let the students keep their bugs. A good idea to recover your costs is to offer the principle a deal he can't refuse, that is the chance to buy the "bugs".

STUDENT: ____________________

52 Discharge Tubes

Aim: To observe the emission spectra of various inert gases , corresponding to the quantum energy levels of the electron orbitals.

Equipment

Discharge tubes: Hydrogen, Helium, Neon, Argon
Power Supply, 6V DC
Induction Coil
Connecting leads,
4Spectroscopes

Procedure

Insert the hydrogen discharge tube into the mounting.
Connect the high voltage terminals of the induction coil to the terminals of the discharge tube mounting.
Connect the low voltage input terminals of the induction coil to the power supply, 6V DC.
Turn off the lights and draw the blinds.
Turn on the power.
Observe the light from the discharge tube through a spectroscope.
Repeat for the other gas tubes.

Results: ____

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Conclusion: ____

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52

Discharge Tubes

Topics: Atoms & Molecules   Nuclear Physics

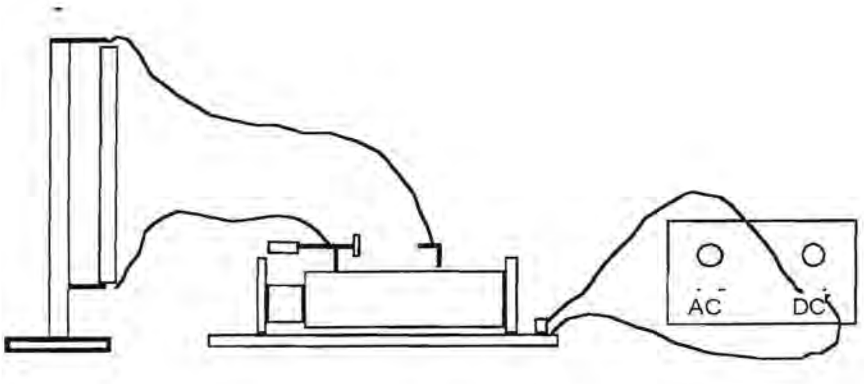
Aim: To observe the emission spectra of various inert gases , corresponding to the quantum energy levels of the electron orbitals.

Equipment

Discharge tubes:
Hydrogen, Helium, Neon, Argon
Power Supply, 6V DC
Induction Coil
Connecting leads,
4Spectroscopes

Procedure

Insert the hydrogen discharge tube into the mounting.
Connect the high voltage terminals of the induction coil to the terminals of the discharge tube mounting.
Connect the low voltage input terminals of the induction coil to the power supply, 6V DC.
Turn off the lights and draw the blinds.
Turn on the power.
Observe the light from the discharge tube through a spectroscope.
Repeat for the other gas tubes.



Result: Sharp emission lines are visible though the spectroscope, many more lines appearing for the heavier gasses.

Conclusion: The heavier gases have larger atoms with more electron shells and subshells and so more possible quantum jumps between shells. Each emission spectrum line represents a particular quantum jump between electron shells.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION . The induction coil produces very high voltages.

STUDENT:________________

53 Displacing Copper

Aim: To observe the reaction, if any, of copper sulfate with various other solid metals.

Equipment

Test Tubes, five
Test Tube Rack
Magnesium Ribbon
Aluminium foil
Zinc granules
Iron nail
Lead Foil
Copper Sulfate 0.25M, 6%
Hydrochloric Acid 5M 50%
in Dropper Bottle.

Procedure

Place a sample of each metal in separate test tubes.
Add 3cm of copper sulfate solution to each test tube.
Add 2 drops of the acid (to remove oxide coatings).
Examine the metals after 10 -30 mins.

Metal	Reaction

Results: ____

____

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Conclusion: ____

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53

Displacing Copper

Topics: Ions Chem Reactions

Aim: To observe the reaction, if any, of copper sulfate with various other solid metals.

Equipment

Test Tubes, five
Test Tube Rack
Magnesium Ribbon
Aluminium foil
Zinc granules
Iron nail
Lead Foil
Copper Sulfate 0.25M, 6%
Hydrochloric Acid 5M 50%
in Dropper Bottle.

Procedure

Place a sample of each metal in separate test tubes.
Add 3cm of copper sulfate solution to each test tube.
Add 2 drops of the acid (to remove oxide coatings).
Examine the metals after 10 -30 mins.

Result: All the metals gather a dull red deposit

Conclusion: The dull red deposit is metallic copper. Copper ions are displaced from solution by the solid metals forming their own ions in solution.

Risk Level: Mild Hazard: Copper sulfate is harmful if ingested and may irritate the skin or eyes. Hydrochloric acid 5M is highly corrosive and should only be handled by the teacher.

STUDENT:________________

54 DISTILLATION

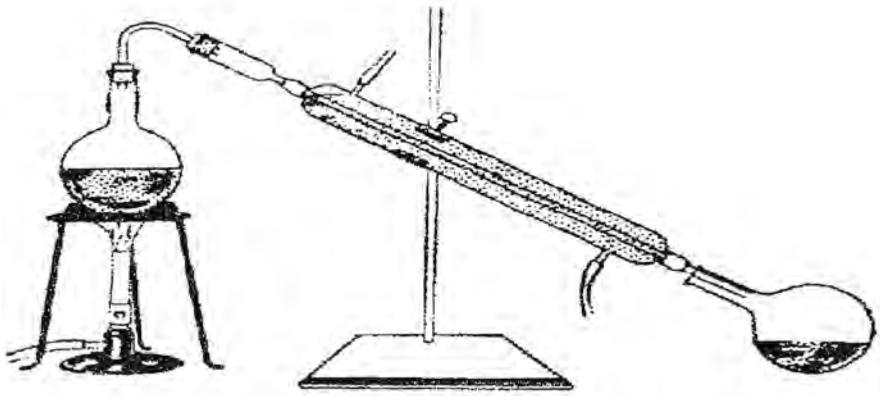
Aim: To separate Camphor Oil from leaves.

Equipment

Condenser
Side arm flask
Two Retort Stands
Two Boss Heads
Two clamps
Camphor Laurel
Leaves
Scissors
Rubber Stoppers
Bunsen
Beaker

Procedure

Chop the leaves finely with scissors and add to the flask.
Half fill the flask with water.
Set up the apparatus as shown below.
Light the Bunsen.
Start water flow though condenser.



Results: ____

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Conclusion: ____

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54

DISTILLATION

Topics: Separating Matter

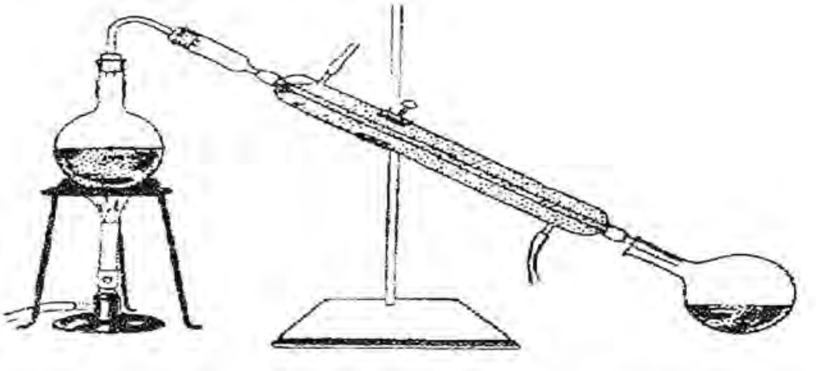
Aim: To separate Camphor Oil from leaves.

Equipment

Condenser
Side arm flask
Two Retort Stands
Two Boss Heads
Two clamps
Camphor Laurel
Leaves
Scissors
Rubber Stoppers
Bunsen
Beaker

Procedure

Chop the leaves finely with scissors and add to the flask.
Half fill the flask with water.
Set up the apparatus as shown below.
Light the Bunsen.
Start water flow though condenser.



Result: Vapours from the flask condense and drip into the beaker as a clear liquid smelling strongly of Camphor oil.

Conclusion: Distillation can be used to purify liquids leaving behind any dissolved salts or other high boiling point substances

Risk Level: Low Hazard: Since the apparatus set up is delicate this should be a teacher demonstration.

STUDENT:________________

55 Divers Response

Aim: To demonstrate the response of heart beat to sudden cold.

Equipment

Stop watch

Ice

Procedure

Take the pulse of a student.

Monitor the pulse as the students face is plunged into ice water.

Results: ____

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Conclusion: ____

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55

Divers Response

Topics: Coordination

Aim: To demonstrate the response of heart beat to sudden cold.

Equipment

Stop watch

Ice

Procedure

Take the pulse of a student.

Monitor the pulse as the students face is plunged into ice water.

Result: The pulse stops briefly.

Conclusion: Sudden cold to the face presents a shock which momentarily interrupts heart rhythm. In emergencies this technique can substitute for electric shock treatment during a heart attack.

Risk Level: Mild Hazard.

STUDENT:________________

56 Dogs and Bats

Aim: To determine the range of human hearing.

Equipment

Audio Oscillator
Power supply, 12V DC
Connecting leads, 2

Procedure

Connect the Audio Oscillator to the power supply.
Set the oscillator at about 2000 Hertz.
Turn on the power and speaker, adjusting the volume to be clear but not loud.
Gradually increase the frequency to 10,000Hz .
Switch off the speaker, reduce back to 1000Hz then increase the decade to 10,000 Hz.
Gradually increase the frequency to 30000Hz.
Reverse the process quickly moving through the decades to the 10 - 100 Hz range and slowly approach 50Hz.

Record the highest frequency heard by everyone. ________
Record the highest frequency heard by anyone. _________
Record the lowest frequency heard by everyone. ________
Record the lowest frequency heard by anyone as a continuous sound rather than distinct clicks. _________

Results: ____

____

____

Conclusion: ____

____

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56

Dogs and Bats

Topics: Waves Coordination

Aim: To determine the range of human hearing.

Equipment

Audio Oscillator
Power supply, 12V DC
Connecting leads, 2

Procedure

Connect the Audio Oscillator to the power supply.
Set the oscillator at about 2000 Hertz.
Turn on the power and speaker, adjusting the volume to be clear but not loud.
Gradually increase the frequency to 10,000Hz .
Switch off the speaker, reduce back to 1000Hz then increase the decade to 10,000 Hz.
Switch the speaker on and ask all who can hear the sound to raise their hands, raising your own as well.
Hands will be lowered when the sound is beyond hearing.

Gradually increase the frequency to 30000Hz.
You may have to be the first to lower your hand.
Reverse the process quickly moving through the decades to the 10 - 100 Hz range and slowly approach 50Hz.
Hands should be lowered when the sound is no longer continuous but a series of clicks.

Result: Most people have a hearing range between 50 and 25000Hz.

Conclusion: Older people (teachers) tend to have some hearing loss at high frequencies since loud noises cause cumulative damage to the fine hairs of the inner cochlea. Elderly people are often not deaf but lacking sufficient high range hearing to distinguish consonants eg 's' and 'st', hence the reply "Don't shout, just speak clearly."

Risk Level: Low Hazard

STUDENT:________________

57 Earthquake Waves

Aim: To use the information provided to locate the epicentre of an Earthquake.

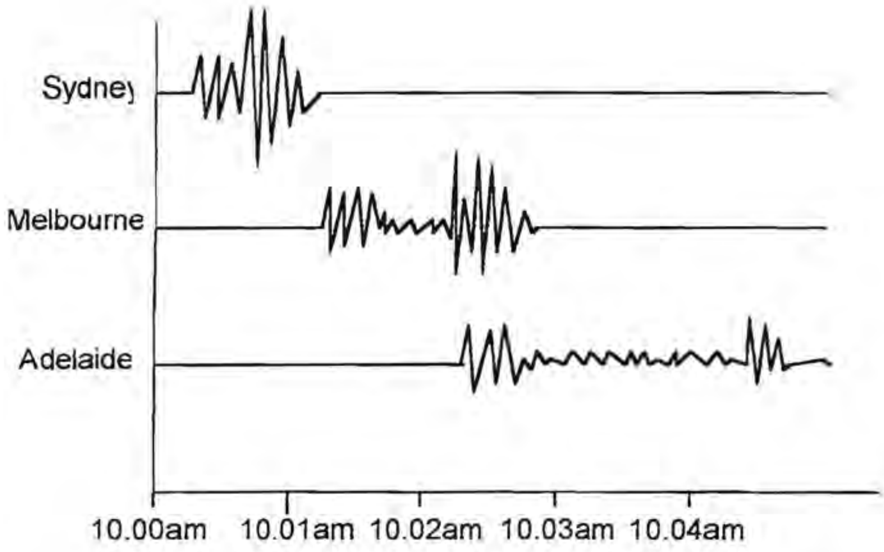
Equipment

Compass
Pencil
Seismograph records
Simple scaled map of Australia
Ruler

Procedure

P waves travel faster than S waves.
Identify the P waves group and the S wave group in the seismograph trace from each city.
Measure the time difference between the first S peak and first P peak in each trace.
Using the approximation : each second of difference equals ten kilometers of distance, work out how far each city is from the earthquake epicentre.
From the scale on your map set the compass to the epicentre distance from Sydney and draw a circle around

Sydney.
Repeat this process for the other two cities with their larger circles.
Where the circles overlap is the region of the epicentre.



Results: ____

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Conclusion: ____

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57

Earthquake Waves

Topics: Waves Volcano & Quakes

Aim: To use the information provided to locate the epicentre of an Earthquake.

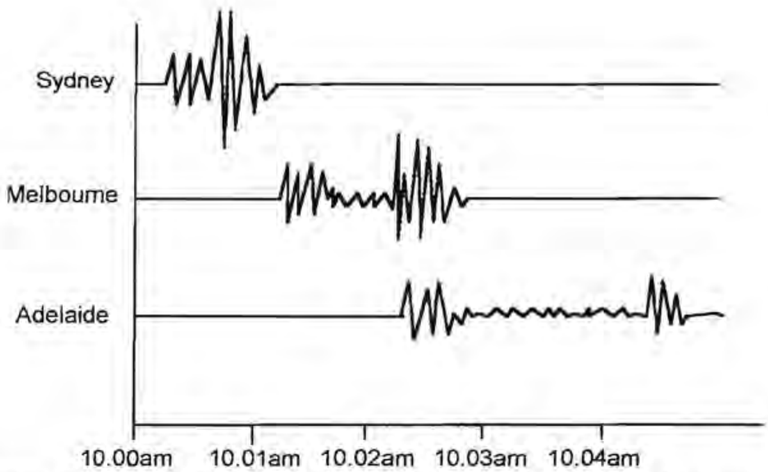
Equipment

Compass
Pencil
Seismograph records
Simple scaled map of Australia
Ruler

Procedure

P waves travel faster than S waves.
Identify the P waves group and the S wave group in the seismograph trace from each city.
Measure the time difference between the first S peak and first P peak in each trace.
Using the approximation : each second of difference equals ten kilometers of distance, work out how far each city is from the earthquake epicentre.
From the scale on your map set the compass to the epicentre distance from Sydney and draw a circle around

Sydney.
Repeat this process for the other two cities with their larger circles.
Where the circles overlap is the region of the epicentre.



Result: The epicentre is in a region South West of Sydney. Sydney (5.5mm. 22secs, 220km) Melbourne (14mm,56secs,560km) Adelaide (31mm,124secs, 1240km).

Conclusion: Seismograph traces from three locations can be used to locate the epicentre of an Earthquake. P waves can travel at up to 10,000km/hr. This is a good exersize but requires two scale conversions which are likely to confuse lower ability classes.

Risk Level: Low Hazard

STUDENT:________________

58 Electrolysis

Aim: To separate water into its component elements.

Equipment

Hydrochloric Acid 1M, 10%
Power Supply 2-12Volt DC
Electrolysis Apparatus

Procedure

Add 20ml of the acid to 200ml of water.
Add the solution to the apparatus reservoir and then release the stop cocks so each vertical column is filled.
Connect electrodes to 6 volts DC current.
Allow the experiment to run for 30 to 60 minutes.
Draw the apparatus below.

Results: ____

____

____

Conclusion: ____

____

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58

Electrolysis

Topics: Matter Elements Ions

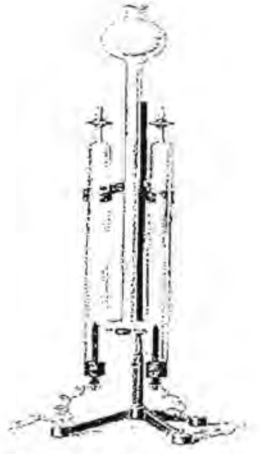
Aim: To separate water into its component elements.

Equipment

Hydrochloric Acid 1M, 10%
Power Supply 2-12Volt DC
Electrolysis Apparatus

Procedure

Add 20ml of the acid to 200ml of water.
Add the solution to the apparatus reservoir and then release the stop cocks so each vertical column is filled.
Connect electrodes to 6 volts DC current.
Allow the experiment to run for 30 to 60 minutes.



Result: The cathode produces twice as much gas as the anode.

Conclusion: The Anode gas is Oxygen and the cathode gas is hydrogen.

Risk Level: Moderate Hazard: Recommended only as a Teacher Demonstration due to the delicacy and expense of the apparatus.

STUDENT:________________

59 Electrolytic Plating

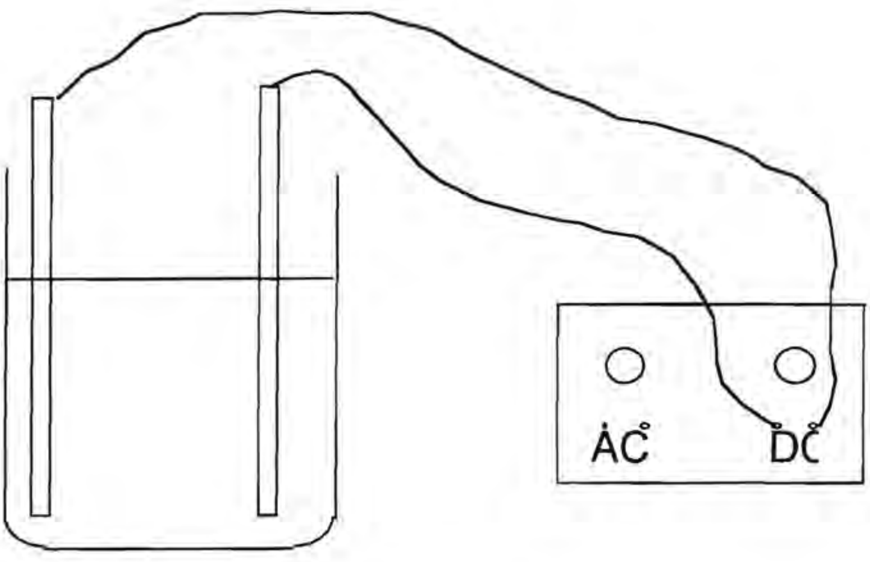
Aim: To demonstrate nickel plating.

Equipment

Copper Strips, 2 (one may be a brass key)
Nickel Sulphate
Power Supply, DC 2V
Connecting leads, 2
Beaker, 250ml
Steel wool
Alligator clips, two

Procedure

Dissolve 5g of nickel sulfate in 200mls of water.
Thoroughly clean one copper strip with steel wool and pick it up with an alligator clip.
Connect the clip to the negative DC terminal of the power supply and place the strip in the nickel solution.
Use the other alligator clip to connect the second copper strip to the positive DC terminal of the power supply.
Place the second strip in the solution ensuring it cannot touch the cleaned strip.
Set the voltage to 2V and turn on the power for 20 mins.



Results: ____

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Conclusion: ____

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Electrolytic Plating

Topics: Electricity Ions

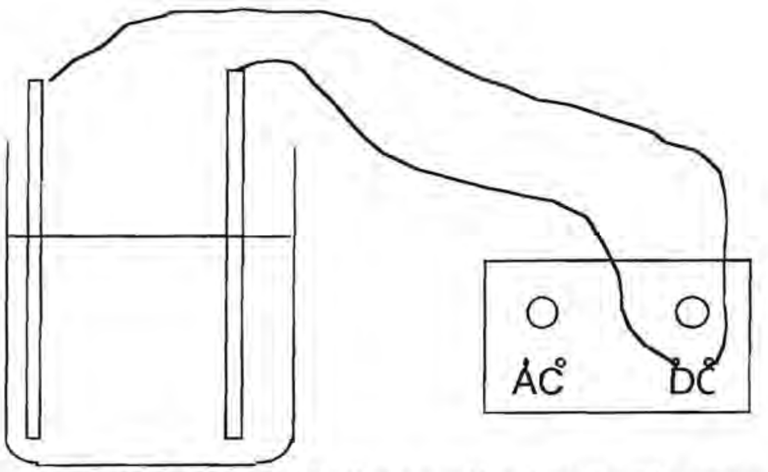
Aim: To demonstrate nickel plating.

Equipment

Copper Strips, 2 (one may be a brass key)
Nickel Sulphate
Power Supply, DC 2V
Connecting leads, 2
Beaker, 250ml
Steel wool
Alligator clips, two

Procedure

Dissolve 5g of nickel sulfate in 200mls of water.
Thoroughly clean one copper strip with steel wool and pick it up with an alligator clip.
Connect the clip to the negative DC terminal of the power supply and place the strip in the nickel solution.
Use the other alligator clip to connect the second copper strip to the positive DC terminal of the power supply.
Place the second strip in the solution ensuring it cannot touch the cleaned strip.
Set the voltage to 2V and turn on the power for 20 mins.



Result: The copper strip connected to the negative terminal became coated with shiny silver metal.

Conclusion: The negative electrode donates electrons to the positive nickel ions in the solution which become deposited as nickel atoms.

Risk Level: Moderate Hazard: Nickel sulfate is toxic if ingested and should be treated as a suspected carcinogen.

STUDENT:________________

60 Electron Beams

Aim: To demonstrate the deflection of electrons in a magnetic field.

Equipment

Fluorescent Strip vacuum tube
Induction Coil
Power Supply, 6V DC
connecting leads, 4
Bar Magnet

Procedure

Connect the high voltage terminals of the induction coil to the terminals of the vacuum tube.
Connect the low voltage input terminals of the induction coil to the power supply, 6V DC.
Turn off the lights and draw the blinds.
Turn on the power.
A yellow beam will appear on the fluorescent strip - if not reverse the connecting leads on the vacuum tube.
Point the north bar of the magnet perpendicular to the beam.
Try the south pole of the magnet.

Draw the apparatus and the effect of the magnet on the electron beam.

Results: ____

____

____

Conclusion: ____

____

____

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60

Electron Beams

Topics: atoms and molecules   Nuclear Physics   Electromagnetism

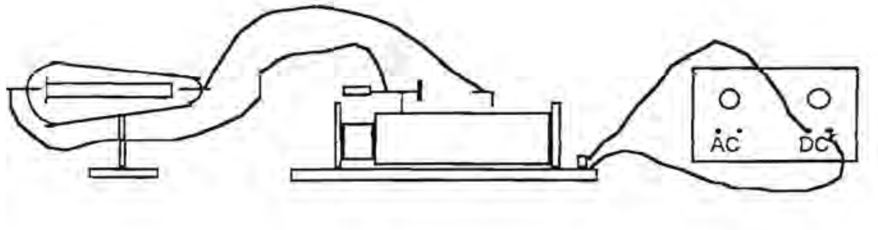
Aim: To demonstrate the deflection of electrons in a magnetic field.

Equipment

Fluorescent Strip vacuum tube
Induction Coil
Power Supply, 6V DC
connecting leads, 4
Bar Magnet

Procedure

Connect the high voltage terminals of the induction coil to the terminals of the vacuum tube.
Connect the low voltage input terminals of the induction coil to the power supply, 6V DC.
Turn off the lights and draw the blinds.
Turn on the power.
A yellow beam will appear on the fluorescent strip - if not reverse the connecting leads on the vacuum tube.
Point the north bar of the magnet perpendicular to the beam.
Try the south pole of the magnet.



Result: The beam curves in opposite directions depending on the magnetic pole applied.

Conclusion: A beam of electrons experiences a force perpendicular to its motion and the magnetic field according to the left hand rule.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY. The induction coil produces very high voltages. X-rays from the electron beam produce a hazard zone of 3 metre radius. Limit your exposure time.

STUDENT:________________

61 Empirical Formula

Aim: To determine the empirical formula for magnesium oxide.

Equipment
Magnesium ribbon
Steel wool
crucible and lid
pipe clay triangle
tripod and Bunsen
balance, 0.1g accuracy

Procedure
Weigh the crucible and lid (W1).
Clean a 20cm length of magnesium ribbon with steel wool.
Coil the magnesium into the crucible and weigh again (w2).
Heat the crucible mounted on a tripod and pipe clay triangle.
Lift the lid occasionally to allow oxygen to enter while restricting the escape of magnesium oxide smoke.
After 10 minutes allow the crucible to cool.
Weigh the crucible again (W3).

Atomic Mass of Magnesium = 24.31
Atomic Mass of Oxygen =16.00

Moles of Magnesium = $\dfrac{W2 - W1}{24.31} = \dfrac{\_\_\_\_ - \_\_\_\_}{24.31} =$

Moles of Oxygen = $\dfrac{W3 - W2}{16.00} = \dfrac{\_\_\_\_ - \_\_\_\_}{16.00} =$

Ratio of Mg : O = $\dfrac{\text{Moles Mg}}{\text{Moles Mg}} : \dfrac{\text{Moles O}}{\text{Moles Mg}} =$ ______ : ______

Results: ____

____

____

Conclusion: ____

____

____

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61

Empirical Formula

Topics: Making Compounds Mole Concept

Aim: To determine the empirical formula for magnesium oxide.

Equipment

Magnesium ribbon
Steel wool
crucible and lid
pipe clay triangle
tripod and Bunsen
balance, 0.1g accuracy

Procedure

Weigh the crucible and lid (W1).
Clean a 20cm length of magnesium ribbon with steel wool.
Coil the magnesium into the crucible and weigh again (w2).
Heat the crucible mounted on a tripod and pipe clay triangle.
Lift the lid occasionally to allow oxygen to enter while restricting the escape of magnesium oxide smoke.
After 10 minutes allow the crucible to cool.
Weigh the crucible again (W3).

Atomic Mass of Magnesium = 24.31
Atomic Mass of Oxygen =16.00

Moles of Magnesium = $\frac{W2 - W1}{24.31} = \frac{\_\_\_\_ - \_\_\_\_}{24.31} =$

Moles of Oxygen = $\frac{W3 - W2}{16.00} = \frac{\_\_\_\_ - \_\_\_\_}{16.00} =$

Ratio of Mg : O = $\frac{\text{Moles Mg}}{\text{Moles Mg}} : \frac{\text{Moles O}}{\text{Moles Mg}} =$ ______ : ______

Result: The ratio of Magnesium to Oxygen in Magnesium Oxide is 1:1

Conclusion: The Empirical Formula of Magnesium Oxide is MgO

Risk Level: Moderate Hazard: Magnesium is highly reactive and burns with a brilliant white flame. Magnesium Oxide smoke is alkaline an irritating to airways. This experiment should only be performed in a WELL VENTILATED SPACE OR IN A FUME HOOD IF ASTHMATICS ARE PRESENT.

STUDENT:____________________

62 Esters

Aim: To produce some simple esters from alcohols and organic acids.

Equipment

Fume Hood
Large Beaker, 500ml
Bunsen and tripod
Test Tubes, six
Marking Pen
1- Butanol
1- pentanol
3- methyl - 1- Butanol (amyl alcohol)
Methanol
Ethanol
Salacylic acid
Acetic Acid , Glacial
Formic Acid
Sulfuric Acid, Concentrated
Test tube rack

Procedure

Place 2ml samples of each alcohol in separate test tubes.
Label the test tubes.
Heat 400ml of water to boiling in a beaker.
Remove heat and place the beaker in a fume hood.
Add 2ml of Acetic acid to each tube.
Add 5 drops of Sulfuric acid to each tube.
Place the test tubes in the hot water for 15 minutes.
Carefully try to identify the odour from each tube
Option: replace the acetic acid with 1cm of Salacylic acid
Option : replace the acetic acid with Formic acid

Name the esters formed.

Describe the odour of the products

Alcohol	Acetic acid	Salacylic Acid	Formic Acid
Methanol			
Ethanol			
Butanol			
Amyl Alcohol			
Pentanol			

Results: ____

____

____

Conclusion: ____

____

____

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62

Esters

Topics: Organic Chem Chemistry Energy in Life

Aim: To produce some simple esters from alcohols and organic acids.

Equipment

Fume Hood
Large Beaker, 500ml
Bunsen and tripod
Test Tubes, six
Marking Pen
1- Butanol
1- pentanol
3- methyl - 1- Butanol (amyl alcohol)
Methanol
Ethanol
Salacylic acid
Acetic Acid , Glacial
Formic Acid
Sulfuric Acid, Concentrated
Test tube rack

Procedure

Place 2ml samples of each alcohol in separate test tubes.
Label the test tubes.
Heat 400ml of water to boiling in a beaker.
Remove heat and place the beaker in a fume hood.
Add 2ml of Acetic acid to each tube.
Add 5 drops of Sulfuric acid to each tube.
Place the test tubes in the hot water for 15 minutes.
Carefully try to identify the odour from each tube
Option: replace the acetic acid with 1cm of Salacylic acid
Option : replace the acetic acid with Formic acid

Result: The odours of the original reactants were changed into completely new odours.

Conclusion: ORGANIC ACID + ALCOHOL > ESTER
Methyl Salacilate (oil of winter green) Amyl Acetate (Banana) Ethyl Acetate (Pineapple)

Risk Level: HAZARDOUS: Glacial acetic acid and Concentrated sulfuric acid are highly corrosive, produces noxious fumes, and should only be handled by the teacher.. Any skin contact with acids must be treated by immediate washing. All alcohols and esters are to be considered volatile and flammable. The fumes produced in this experiment may overpower smell senses and affect asthmatics. Use a fume hood. Formic acid is only for use by Teachers.

STUDENT:________________

63 Exo/Endothermic Rns. 1

Aim: To measure the energy changes associated with several salts changing from the solid to aqueous state.

Equipment

Thermometer 0-100
Beaker, 100ml
Sodium Hydroxide
Ammonium Chloride
Sodium Ethanoate
Sodium Chloride

Procedure

Add 30mls of water to the beaker .
Measure its temperature with the thermometer.
Add about one teaspoon of sodium hydroxide.
Mix carefully with the thermometer and record the maximum or minimum temperature reached over 3 mins.
Rinse the beaker and thermometer.
Repeat the procedure for ammonium chloride.
Repeat the procedure for sodium ethanoate.
Repeat the procedure for sodium chloride.

Salt	Original Temp	New Temp.

Results: ____

____

____

Conclusion: ____

____

____

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63

Exo/Endothermic Rns. 1

Topics: Chem Reactions Chemical Energy

Aim: To measure the energy changes associated with several salts changing from the solid to aqueous state.

Equipment

Thermometer 0-100
Beaker, 100ml
Sodium Hydroxide
Ammonium Chloride
Sodium Ethanoate
Sodium Chloride

Procedure

Add 30mls of water to the beaker .
Measure its temperature with the thermometer.
Add about one teaspoon of sodium hydroxide.
Mix carefully with the thermometer and record the maximum or minimum temperature reached over 3 mins.
Rinse the beaker and thermometer.
Repeat the procedure for ammonium chloride.
Repeat the procedure for sodium ethanoate.
Repeat the procedure for sodium chloride.

Adding an insoluble salt would be a "Control".

Result: A slight temperature decrease is noted with sodium chloride, a large temperature increase with sodium hydroxide, a small decrease with sodium acetate and a larger decrease with ammonium chloride.

Conclusion: Some salts release energy as they dissolve (Exothermic Reaction) while other salts absorb energy as they dissolve (Endothermic Reaction).

Risk Level: Mild Hazard: sodium hydroxide is caustic and can damage the skin, any contact should be treated with prolonged washing in water.

STUDENT:________________

64 Exo/Endothermic Rns. 2

Aim: To measure the energy changes associated with two different reactions.

Equipment

Copper Sulfate (saturated Solution)
Steel Wool
Ammonium Thiocyanate
Barium Hydroxide
Test Tube and stopper
Beaker, 100ml
Thermometer, -10 -100

Procedure

Record room temperature.
1/ Place about half a teaspoon of ammonium thiocyanate in a test tube.
Add the same amount of barium hydroxide.
Stopper the test tube and shake until a solution forms.
Measure the temperature of the solution.
Dispose of the mixture into the lab waste bottle in the fume hood.
2/Place about 25ml of the copper sulfate solution into the beaker.

Place a wad of steel wool into the beaker and hold it below the surface with the thermometer.
Record the temperature.

Results: ____

____

____

Conclusion: ____

____

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64

Exo/Endothermic Rns. 2

Topics: Chem Reactions Chemical Energy

Aim: To measure the energy changes associated with two different reactions.

Equipment

Copper Sulfate (saturated Solution)
Steel Wool
Ammonium Thiocyanate
Barium Hydroxide
Test Tube and stopper
Beaker, 100ml
Thermometer, -10 -100

Procedure

Record room temperature.
Place about half a teaspoon of Ammonium Thiocyanate in a test tube.
Add the same amount of Barium hydroxide.
Stopper the test tube and shake until a solution forms.
Measure the temperature of the solution.
Dispose of the mixture into the lab waste bottle in the fume hood.
Place about 25ml of the copper sulfate Solution into the beaker.

Place a wad of steel wool into the beaker and hold it below the surface with the thermometer.
Record the temperature.

Result: The thiocyanate reaction with barium hydroxide produces a dramatic temperature drop. The displacement reaction between copper sulfate and iron produces heat.

Conclusion: The reaction between ammonium thiocyanate and barium hydroxide is Endothermic, dissolving in the waters of crystallisation and producing ammonia gas. The reaction between ionic copper and solid iron is Exothermic producing solid copper and iron ions.

Risk Level: Moderate Hazard: Seniors Only: Ammonium thiocyanate and barium hydroxide are toxic and the hydroxide is caustic to the skin. Ammonia vapours are produced and athsmatic should be warned or the tubes opened only in the fume hood. Copper sulfate is harmful if ingested and can damage skin and eyes.

STUDENT:________________

65 Expansion in Solids

Aim: To demonstrate that solids expand when heated.

Equipment

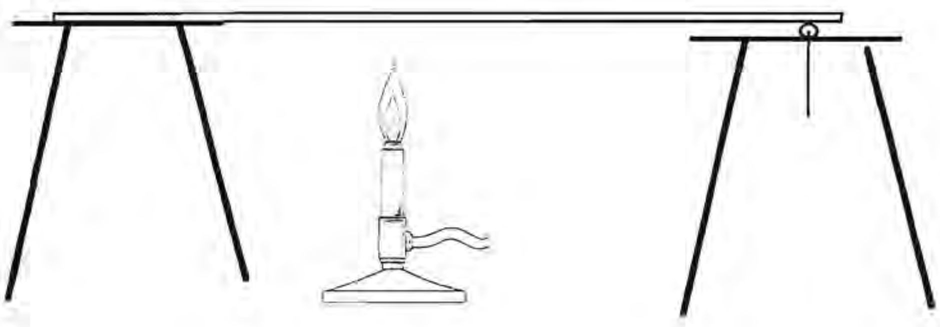
Bimetal strips
Expansion Rings
Metal Rod or pipe, 0.6m
Two tripods
Bunsen
Round pencil
Blue tack
Tooth Pick
Test tube peg

Procedure

1. Lay the metal rod between two tripods.
Place the pencil under one end as a roller.
Use blue tack to affix the tooth pick to the end of the pencil like an indicator needle.
Heat the rod with one or more bunsens.

2. Heat the expansion rings and see how the ball now fits through easily.

3. Heat a bimetal strip held in a test tube peg.



Results: ____

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____

Conclusion: ____

____

____

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65

Expansion in Solids

Topics: Matter Heat

Aim: To demonstrate that solids expand when heated.

Equipment

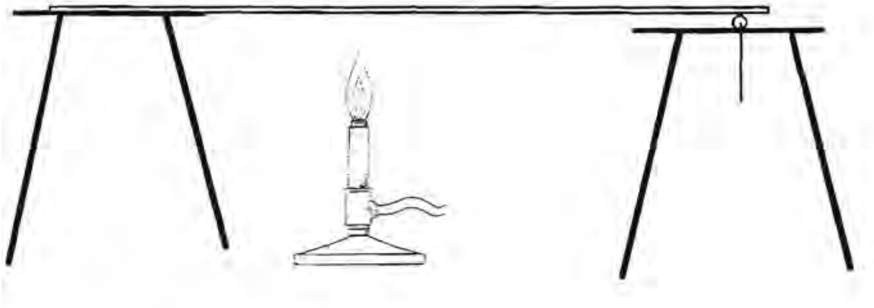
Bimetal strips
Expansion Rings
Metal Rod or pipe, 0.6m
Two tripods
Bunsen
Round pencil
Blue tack
Tooth Pick
Test tube peg

Procedure

1.Lay the metal rod between two tripods.
Place the pencil under one end as a roller.
Use blue tack to affix the tooth pick to the end of the pencil like an indicator needle.
Heat the rod with one or more Bunsens.

2.Heat the expansion rings and see how the ball now fits through easily.

3.Heat a bimetal strip held in a test tube peg.



Result: The tooth pick moved like an indicator gauge as the rod expanded. The expansion ring would allow the ball through after heating. The bimetal strips bend when heated and straighten as they cool.

Conclusion: Solids expand when heated. Different metals expand at different rates so that bimetal strips will bend as one side expands faster than the other.

Risk Level: Low Hazard: Avoid touching the heated metals.

STUDENT:________________

66 Exploding Bubbles

Aim: To demonstrate the powerful energy release when oxygen combines with hydrogen to make water.

Equipment

Side arm Conical Flask
Hydrochloric Acid, 1M,10%
Rubber stopper penetrated by two electrodes
Large plastic tray
Detergent
1 kg Mass
Power Supply, 12V ,DC
Plastic Tubing
Matches

Procedure

Draw the apparatus.
Explain why the bubbles react so strongly.

Results: ____

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Conclusion: ____

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66

Exploding Bubbles

Topics: Reactions Exothermic Rns

Aim: To demonstrate the powerful energy release when oxygen combines with hydrogen to make water.

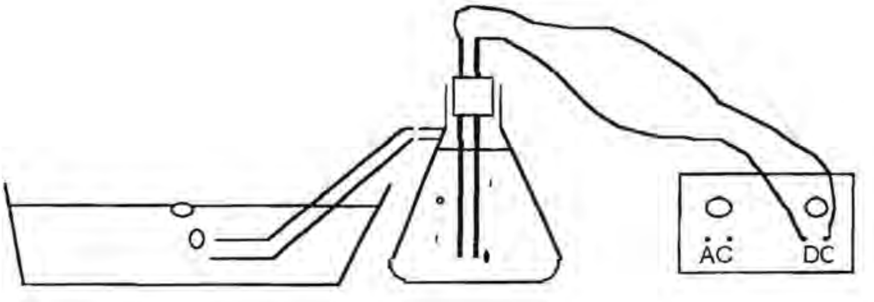
Equipment

Side arm Conical Flask
Hydrochloric Acid, 1M,10%
Rubber stopper penetrated by two electrodes
Large plastic tray
Detergent
1 kg Mass
Power Supply, 12V ,DC
Plastic Tubing
Matches

Procedure

Add 50ml of acid to the conical flask and connect the tubing.
Fill the plastic tray with water and add some detergent .
Use the mass to anchor the free tube in the bottom of the detergent tray.
Add water to the conical flask until the tubing is free of air.
Insert the rubber stopper and connect the electrodes to the power supply.
Leave for 1 hour in a safe place with a warning sign.

Bubbles on the surface of the detergent tray may be ignited with a match yielding a loud explosive pop.



Result: Electrolysis of water yields hydrogen and oxygen. A lighted match ignites this gaseous mixture explosively .

Conclusion: Oxygen and hydrogen gases burn together exothermically to form water. (The Heat of Formation of water is 242 kj per mole)

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY. Hydrogen /oxygen mixture is highly explosive. Under no circumstances should a naked flame be allowed near the gas filled plastic hose.

STUDENT: ____________________

67 Filtration

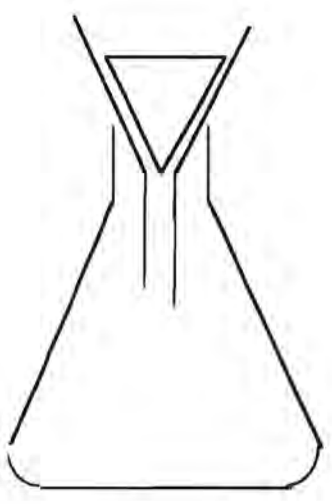
Aim: To separate two substances on the basis of solubility and particle size.

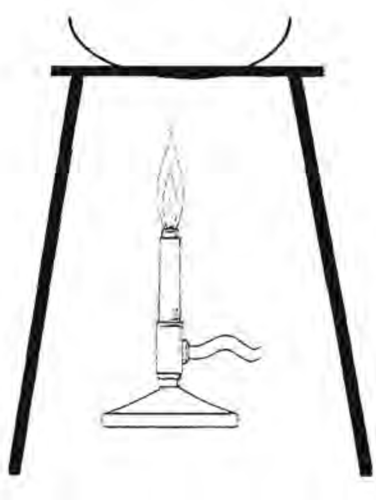
Equipment

Filter Funnel
Filter Paper
Beaker
Conical Flask
Copper Sulfate
Copper Carbonate
Evaporating Basin
Bunsen
Tripod

Procedure

A mixture of copper sulfate and copper carbonate in equal quantities is prepared beforehand.
Add a spatula of the mixture to the beaker.
Add approximately 50mls of water.
After stirring, pour the mixture into the filter paper which is resting in the funnel and conical flask.
Pour the blue filtrate into an evaporating basin and place it on top of a tripod.
Gently heat with a bunsen until nearly all the water has boiled away.





Results: ____

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Conclusion: ____

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67

Filtration

Topics: Matter Separating

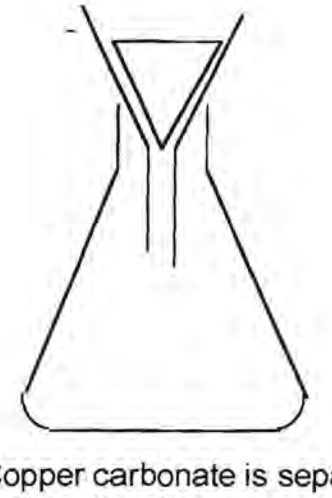
Aim: To separate two substances on the basis of solubility and particle size.

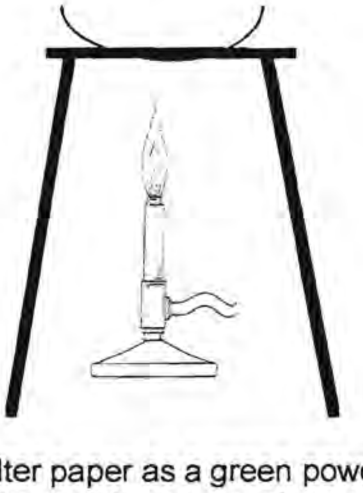
Equipment

Filter Funnel
Filter Paper
Beaker
Conical Flask
Copper Sulfate
Copper Carbonate
Evaporating Basin
Bunsen
Tripod

Procedure

A mixture of copper sulfate and copper carbonate in equal quantities is prepared beforehand.
Add a spatula of the mixture to the beaker.
Add approximately 50mls of water.
After stirring, pour the mixture into the filter paper which is resting in the funnel and conical flask.
Pour the blue filtrate into an evaporating basin and place it on top of a tripod.
Gently heat with a Bunsen until nearly all the water has boiled away.





Result: Copper carbonate is separated in the filter paper as a green powder. Copper sulfate dissolves, passes through the filter and is recovered as crystals after the water is evaporated.

Conclusion: When dissolved, a substance breaks down to tiny invisible particles (atoms) which can pass through a filter. Therefore filter paper can be used to separate soluble substances from insoluble substances.

Risk Level: Mild Hazard: Copper sulfate is harmful if ingested and may irritate skin. Students should use protective glasses when boiling the filtrate.

STUDENT:________________

68 Fire without Burning

Aim: To demonstrate that the heat of some low temperature flames can be offset by evaporation.

Equipment

Small Cotton Cloth
Ethanol or Methanol
Tongs
Large Beaker
Heat Tile

Procedure

Record the steps carried out by the teacher.

Results: ____

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Conclusion: ____

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68

Fire without Burning

Topics: Chemical Energy   Changes of State

Aim: To demonstrate that the heat of some low temperature flames can be offset by evaporation.

Equipment	**Procedure**
Small Cotton Cloth	Mix 50ml of the alcohol with 50ml of water.
Ethanol or Methanol	Soak the cloth in the mixture, then squeeze out excess.
Tongs	Holding the cloth in tongs, ignite with a match.
Large Beaker	Allow to burn for about 10 seconds.
Heat Tile	Extinguish the flame under the beaker.

Result: The cloth was not burnt.

Conclusion: The heat of the burning alcohol was largely absorbed by vaporising the water and so the cloth did not reach ignition temperature.

Risk Level: HAZARDOUS: Teacher Demonstration Only. Alcohols are highly flammable. Be sure the cloth does not drip, that reagent bottles are closed and the bench space clear of all flammables.

STUDENT:________________

69 Floating Iron

Aim: To observe dense materials floating.

Equipment

Liquid Mercury
Fume Hood
Beaker 500mls
Iron Bolt
Lead block (small)
Brass density cube
Tongs
Plastic Ice Cream Bucket

Procedure

Draw the experiment carried out by the teacher.
Explain the result.

Results: ______________________________

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Conclusion: ______________________________

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69

Floating Iron

Topics: Density /Pressure

Aim: To observe dense materials floating.

Equipment

Liquid Mercury
Fume Hood
Beaker 500mls
Iron Bolt
Lead block (small)
Brass density cube
Tongs
Plastic Ice Cream Bucket

Procedure

IN THE FUME HOOD:
Pour 200mls of Mercury into the beaker.
Using the tongs, carefully lower the metal samples to the mercury.

Remove the metal samples and store them in the icecream bucket along with the tongs used.

Result: The metals all float in mercury

Conclusion: Mercury is more dense than iron, brass or lead

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY
Mercury gives off invisible toxic vapours. Spills are difficult to clean. The metal samples and tongs will be contaminated and may form surface amalgams with the mercury.

STUDENT:________________

70 Food Tests

Aim: To test foods for the presence of the major food groups.

Equipment

Gelatine 1% (warm water)
Flour 1%
Glucose 1%
Iodine Dropper Bottle: (dissolve 3g of Potassium Iodide in 100mls of water, add 1.5g Iodine, dilute 1:5 when needed)
Benedicts Soln. Dropper: (2% copper sulfate, 20% sodium carbonate, 17.3% sodium citrate)
Sodium Hydroxide 1M(4%)
Copper sulfate1M,25%
Test Tube Rack
Bunsen
Test tubes, three

Procedure

Place 2cm samples of each food solution in separate test tubes.
Test 1: Add 2 drops of Iodine solution to each tube.
Note the results, clean the tubes and replace the samples.
Test 2: Add two drops of Benedicts solution.
Heat gently over a Bunsen flame.
Note the results, clean the tubes and replace the samples.
Test 3: Add one drop of sodium hydroxide and stir.
Add one drop of copper Sulfate solution.
Note any changes.

Test Substance	Iodine Test	Benedicts Test	Biuret Test
Gelatine			
Flour			
Glucose			

Results: ____

____

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Conclusion: ____

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70

Food Tests

Topics: Energy in Life Organic Chem

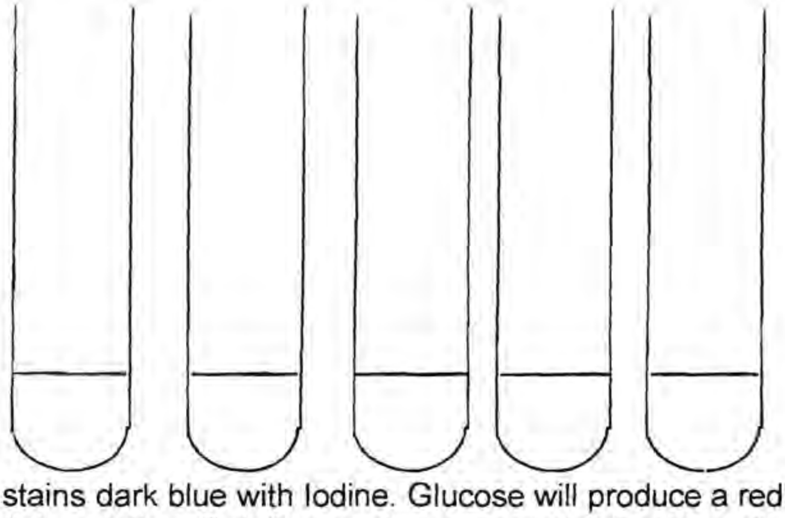
Aim: To test foods for the presence of the major food groups.

Equipment

Gelatine 1% (warm water)
Flour 1%
Glucose 1%
Iodine Dropper Bottle: (dissolve 3g of Potassium Iodide in 100mls of water, add 1.5g Iodine, dilute 1:5 when needed)
Benedicts Soln. Dropper: (2% copper sulfate, 20% sodium carbonate, 17.3% sodium citrate)
Sodium Hydroxide 1M(4%)
Copper sulfate1M,25%
Test Tube Rack
Bunsen
Test tubes, three

Procedure

Place 2cm samples of each food solution in separate test tubes.
Test 1: Add 2 drops of Iodine solution to each tube.
Note the results, clean the tubes and replace the samples.
Test 2: Add two drops of Benedicts solution.
Heat gently over a Bunsen flame.
Note the results, clean the tubes and replace the samples.
Test 3: Add one drop of sodium hydroxide and stir.
Add one drop of copper Sulfate solution.
Note any changes.



Result: Flour stains dark blue with Iodine. Glucose will produce a red precipitate with Benedicts solution. Gelatine produces a red violet colour with the alkaline copper Sulfate.

Conclusion: Iodine tests for complex carbohydrates. Benedicts solution tests for sugars (reducing types). Alkaline copper sulfate tests for proteins (Biuret test for amino acids).

Risk Level: Mild Hazard: Copper sulfate solutions are harmful if ingested. Iodine solution stains the skin dark brown and is harmful if ingested. Sodium hydroxide is caustic and any skin contact must be treated by prolonged washing. Perhaps the greatest risk is heating small quantities in a test tube which can produce flash boiling.

STUDENT:________________

71 Force Table

Aim: To demonstrate that the vector sum of balanced forces will form geometrically closed figure.

Equipment

Plywood(circular, 50cm)
Bench pulleys, four
Mass carriers, four
masses
strings, 30cm, four
key ring

Procedure

Support the ply sheet horizontally by adding legs or just by placing it on top of a slightly smaller object 20cm tall.
Affix the bench pulleys at various positions on the perimeter.
Tie each string to the key ring, passing over a pulley and then tied to a mass carrier.
Adjust the balance of string tensions by adding masses or changing pulley locations until the key ring forms a bulls eye over the centre of the force table.
Record the angles and masses on each string.

Draw these forces as sequential vectors on graph paper.
Repeat with a new set of masses and pulley positions.

Vector	Angle	Force
1		
2		
3		
4		
repeat 1		
repeat 2		
repeat 3		
repeat 4		

Results: ____

____

____

Conclusion: ____

____

____

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71

Force Table

Topics: Forces

Aim: To demonstrate that the vector sum of balanced forces will form geometrically closed figure.

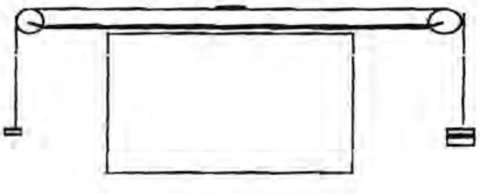
Equipment

Plywood(circular, 50cm)
Bench pulleys, four
Mass carriers, four
masses
strings, 30cm, four
key ring

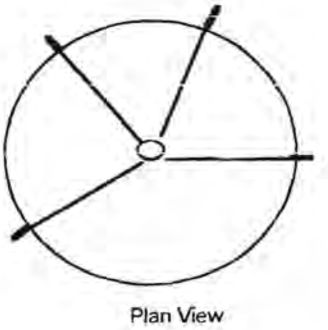
Procedure

Support the ply sheet horizontally by adding legs or just by placing it on top of a slightly smaller object 20cm tall.
Affix the bench pulleys at various positions on the perimeter.
Tie each string to the key ring, passing over a pulley and then tied to a mass carrier.
Adjust the balance of string tensions by adding masses or changing pulley locations until the key ring forms a bulls eye over the centre of the force table.
Record the angles and masses on each string.

Draw these forces as sequential vectors on graph paper.
Repeat with a new set of masses and pulley positions.



Side View



Plan View

Result: When drawn as sequential vectors the balanced forces always formed a closed quadrilateral.

Conclusion: Each force consists of two components. If any group of forces are in balance their vector sum must be zero. If the vector sum is zero so must be the sum of the components. Therefore if the forces are drawn a sequential vector lines the zero sum of components will ensure the lines return to the origin to form a closed figure.

Risk Level: Low Hazard.

STUDENT:

72 Fountain Expt

Aim: To demonstrate air pressure and the fallacy of "Suction".

Equipment

Round Bottom Flask
Glass tubing
Rubber stopper with hole
Bunsen
Beaker, 500ml
Potassium Permanganate

Procedure

Draw the experiment carried out by the teacher.
Explain the result.

Results:

Conclusion:

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72

Fountain Expt

Topics: Density/Pressure

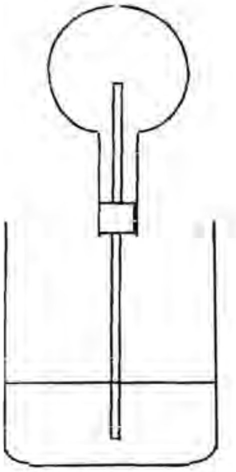
Aim: To demonstrate air pressure and the fallacy of "Suction".

Equipment

Round Bottom Flask
Glass tubing
Rubber stopper with hole
Bunsen
Beaker, 500ml
Potassium Permanganate

Procedure

Fill the beaker with water and add a few crystals of potassium Permanganate for colour.
Add about 20ml of water to the flask.
Fit the tubing and stopper.
Heat the flask over a Bunsen until the water boils vigorously.
Invert the flask so that the tubing is plunged into the beaker.



Result: The dye solution spurts powerfully into the flask like a purple fountain.

Conclusion: Boiling water in the flask creates steam which expels air. When the flask is inverted and no longer heated, the steam condenses leaving a near vacuum. Air pressure on the dye solution forces it upward to fill the vacuum.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY, WEAR EYE PROTECTION. Beware of implosion of the inverted flask . Use only heavy, round bottom flasks. Do not overheat the flask else it may shatter when the cold dye strikes.

STUDENT:__________________

73 Friction

Aim: To examine some of the factors affecting friction.

Equipment

Iron Weight, 250g
String
Mass Carrier, Masses
Bench Pulley
Stop Watch
Oil
Plywood board

Procedure

Attach one metre of string between the weight and the mass carrier.
Attach the pulley to the side of a laminated bench.
Add masses to the carrier until the weight is just about to slide over the surface (m1)._____kg
Encourage the weight with a slight push and record the time taken for the carrier to fall 0.5 m. (t)._______sec
Spread a few drops of oil on the surface and adjust the mass until the weight is just beginning to slide (m2)._____kg
Place the plywood sheet on the surface and adjust the masses until the weight is just sliding on the plywood (m3). _____kg

Calculations: Static friction on laminate = m1 X 9.8

acceleration = $1/t^2$

Dynamic friction on Laminate = m1 (9.8 - $1/t^2$) = _____N

Static friction on oil = m2 X 9.8 =_____N

Static friction on ply = m3 X 9.8 =_____N

Results: ____

____

____

Conclusion: ____

____

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73

Friction

Topics: Forces

Aim: To examine some of the factors affecting friction.

Equipment

Iron Weight, 250g
String
Mass Carrier, Masses
Bench Pulley
Stop Watch
Oil
Plywood board

Procedure

Attach one metre of string between the weight and the mass carrier.
Attach the pulley to the side of a laminated bench.
Add masses to the carrier until the weight is just about to slide over the surface (m1).
Encourage the weight with a slight push and record the time taken for the carrier to fall 0.5 m. (t).
Spread a few drops of oil on the surface and adjust the mass until the weight is just beginning to slide (m2).
Place the plywood sheet on the surface and adjust the masses until the weight is just sliding on the plywood (m3).

Calculations: Static friction on laminate = m1 X 9.8

acceleration = $1/t^2$

Dynamic friction on Laminate = m1 $(9.8 - 1/t^2)$

Static friction on oil = m2 X 9.8
Static friction on ply = m3 X 9.8

Result: The Static friction is a bit higher than the Dynamic friction. Friction is less with oil but higher on plywood.

Conclusion: Friction is slightly less once something starts moving (until air friction becomes significant). Rough surfaces such as ply wood increase friction. Lubricants such as oil provide a film of molecules which slide over each other and reduce friction.

Risk Level: Low Hazard

STUDENT:________________

74 Fuses

Aim: To demonstrate the principle of a fuse and the conversion of electrical energy into heat.

Equipment

Power supply, 12V DC
Connecting leads, 2
Alligator clips, 2
Steel Wool
Heat tile

Procedure

Connect the leads to the DC power supply at 12V.
Use the Alligator clips to connect the leads to a tuft of steel wool.
Place the steel wool on a heat tile.
Turn on the power briefly.

Results: ____

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Conclusion: ____

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74

Fuses

Topics: Electricity Energy

Aim: To demonstrate the principle of a fuse and the conversion of electrical energy into heat.

Equipment

Power supply, 12V DC
Connecting leads, 2
Alligator clips, 2
Steel Wool
Heat tile

Procedure

Connect the leads to the DC power supply at 12V.
Use the Alligator clips to connect the leads to a tuft of steel wool.
Place the steel wool on a heat tile.
Turn on the power briefly.

Result: The strands of steel wool glow and burn.

Conclusion: Steel is a relatively poor conductor compared to copper and has appreciable resistance. As the high ampere current flows its energy is converted to heat $P = I^2R$. The thin strands glow red hot, melt and burn.

Risk Level: Mild Hazard: Unless a heat tile is used the bench surfaces may be damaged.

STUDENT:________________

75 Gas Diffusion 1

Aim: To observe the behaviour of a gas in a closed container.

Equipment

Beaker, 1 litre
Beaker , 100ml
Fume Hood
Copper strips, small
Nitric Acid, Concentrated

Procedure

Draw the experiment carried out by the teacher.
Explain the result.

Results: ____

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Conclusion: ____

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75

Gas Diffusion 1

Topics: Matter Kinetic Theory States of Matter

Aim: To observe the behaviour of a gas in a closed container.

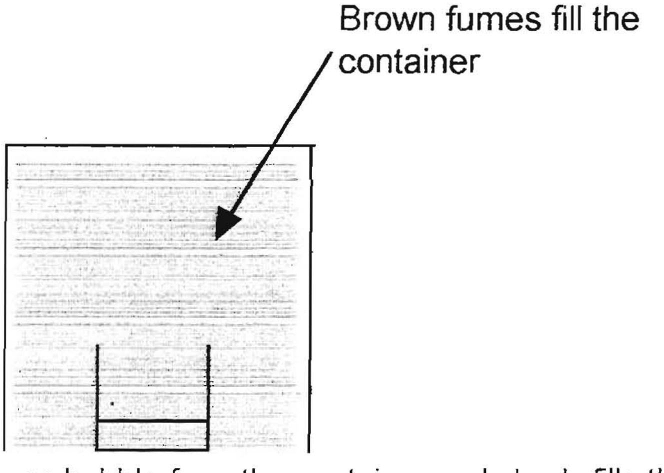
Equipment

Beaker, 1 litre
Beaker , 100ml
Fume Hood
Copper strips, small
Nitric Acid, Concentrated

Procedure

IN THE FUME HOOD:
Add about 30mls of nitric acid to the small beaker.
Add a few strips of copper.
Invert the large beaker over the small beaker.

Note : If you have Bee hives at the school get the hive smoker and demonstrate diffusion to the loud protests of the students.



Result: Brown fumes bubble from the container and slowly fills the large beaker, mixing of its own accord with air already there.

Conclusion: Brown Nitrogen Dioxide gas is produced and spreads through the surrounding air by gaseous diffusion.

Risk Level: HAZARDOUS: Nitric acid, concentrated, is highly corrosive. Rubber gloves are recommended for pouring. Nitrogen Dioxide fumes are also highly corrosive and will form nitric acid on moist mucous membranes. This experiment must be done in a fume hood. When disposing of the experiment pour the acid into the large beaker and then dilute with water. DO NOT POUR CONCENTRATED ACID DOWN THE SINK.

STUDENT:____________________

76 Gas Diffusion 2

Aim: To observe the rapid diffusion of gases.

Equipment

Test tube and Stopper
Iron Sulfide
Hydrochloric acid, 2M, 20%
Fume Hood
Sodium carbonate
Beaker

Procedure

The teacher will produce a small quantity of a gas called hydrogen sulfide by reacting iron sulfide with hydrochloric acid. Record what you notice when the gas is produced even though the ceiling fans are off.

Results: ____

____

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Conclusion: ____

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76

Gas Diffusion 2

Topics: Matter Kinetic Theory States of Matter

Aim: To observe the rapid diffusion of gases.

Equipment

Test tube and Stopper
Iron Sulfide
Hydrochloric acid, 2M, 20%
Fume Hood
Sodium carbonate
Beaker

Procedure

Turn off ceiling fans and close windows.
Add a small quantity of iron sulfide to the test tube.
Add a few centimetres of acid.
When the FIRST student notices the smell place the test tube in the fume hood and neutralise the reaction by pouring into a beaker with some sodium carbonate.
When all the students are aware of the smell, open windows and turn on the fans.
Hint: Do this experiment 10 minutes before the end of class as it is likely to clear your class room.

Alternative; Place a bottle of Butyric acid in the fume hood and open it with the fan off. Wear gloves and stand well clear. Beware that this is a fatty acid and absorbs into skin and clothes . DO NOT SPILL.

Result: This reaction produces Rotten Egg smell which quickly fills the room by diffusion.

Conclusion: The reaction of acid with iron sulfide produces hydrogen Sulfide which is rotten egg gas. The smell spreads rapidly by diffusion and is detectable to the nose in very small quantities.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY. Hydrogen Sulfide gas is toxic and should only be generated in small quantities. Hydrochloric acid 2M is corrosive and any skin contact should be treated with vigorous washing.

STUDENT:________________

77 Glycerol / Permanganate

Aim: To demonstrate a spontaneous exothermic reaction.

Equipment
Potassium Permanganate
Mortar and Pestle
Heat Tile
Glycerol in Dropper bottle

Procedure
Draw the experiment carried out by the teacher.
Explain the result.

Results: ____

____

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Conclusion: ____

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77

Glycerol / Permanganate

Topics: Chemical Reactions   Chemical Energy

Aim: To demonstrate a spontaneous exothermic reaction.

Equipment	**Procedure**
Potassium Permanganate Mortar and Pestle Heat Tile Glycerol in Dropper bottle	Grind about one teaspoon of potassium permanganate in the mortar and pestle and then pour the fine powder onto the heat tile in a mound. IN A FUME HOOD: Add a few drops of glycerol into a depression in the mound.

Result: After a few moments the potassium permanganate busts into smoke and flame.

Conclusion: Potassium Permanganate and Glycerol react spontaneously and exothermically.

Risk Level: HAZARDOUS: IN FUME CUPBOARD ONLY, TEACHER DEMONSTRATION. Potassium Permanganate is a powerful oxidising agent and a strong dye. Choking fumes are produced.

STUDENT:________________

78 Green Fire

Aim: To observe the emission spectra of boron.

Equipment

Boric acid
Methanol
Evaporating Basins, 2
Heat tile

Procedure

Mix 2g of Boric acid with 10ml of methanol in an evaporating basin.
Place 10ml methanol in another basin.
Darken the room.
Ignite the liquids.

Results: ____

____

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Conclusion: ____

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____

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78

Green Fire

Topics: Atoms & Molecules   Light

Aim: To observe the emission spectra of boron.

Equipment

Boric acid
Methanol
Evaporating Basins, 2
Heat tile

Procedure

Mix 2g of Boric acid with 10ml of methanol in an evaporating basin.
Place 10ml methanol in another basin.
Darken the room.
Ignite the liquids.

Result: The methanol burns with a yellow flame while the mixture burns with a bright green flame.

Conclusion: Boron emits green light when heated. The electron orbits of the Boron atom are such that when an excited electron (heated) falls back into its orbit a quanta of light is emitted in the green spectrum. $E = hf$

Risk Level: Moderate Hazard: The room should be well ventilated and great care taken will burning liquids which are easily spilled. Recommended only as a teacher demonstration or for trustworthy students. The teacher should at all times be in charge of the methanol. All benches should be clear of any flammables.

STUDENT: ____________________

79 Green House Effect

Aim: To determine whether Carbon Dioxide absorbs more heat from the sun than air.

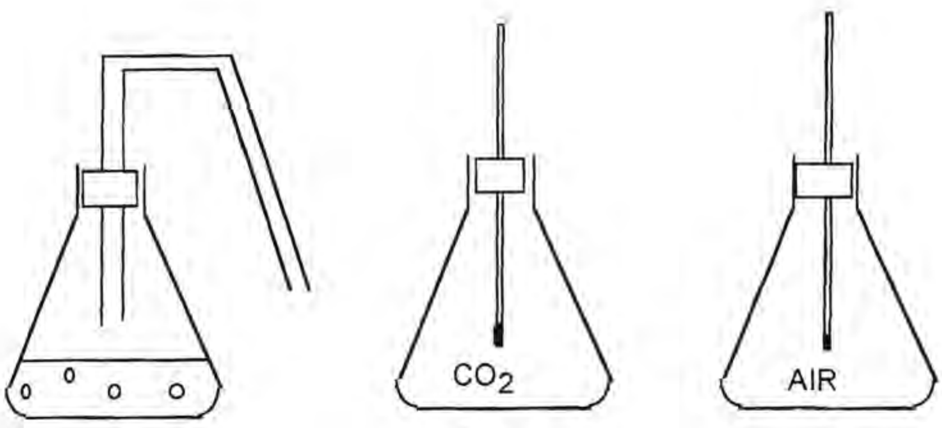
Equipment

3 Conical flasks, 500ml
3 Stoppers, holed
2 thermometers
glass tubing, "U" shaped
marble chips
Hydrochloric Acid, 1M,10%

Procedure

Insert each thermometer through a holed stopper.
Insert glass tubing into the remaining stopper.
Add about 30gms marble chips to one flask.
Add 100mls of acid.
Fit the stopper with the glass tube.
Deliver the gas produced into the base of a second flask.
When the reaction ceases, stopper the collection flask.

Place two flasks into sunlight, one containing air and the other containing carbon dioxide from the reaction.
Record the temperature in each flask every thirty seconds for five minutes. Graph the results.



Results: ____________________

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Conclusion: ____________________

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Green House Effect

Topics: Atmosphere Pollution

Aim: To determine whether Carbon Dioxide absorbs more heat from the sun than air.

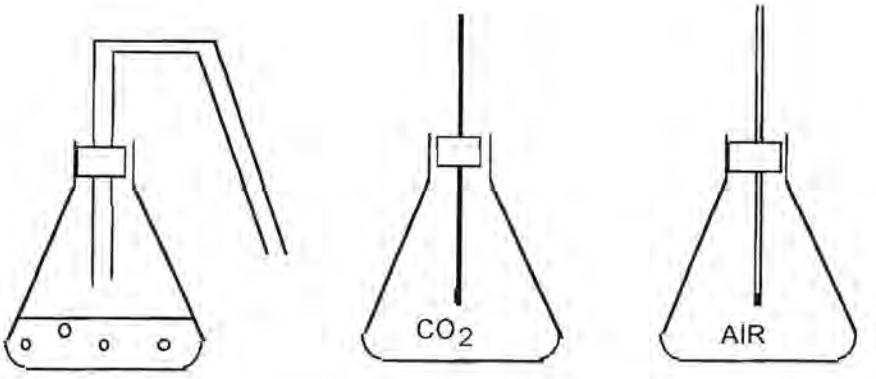
Equipment

3 Conical flasks, 500ml
3 Stoppers, holed
2 thermometers
glass tubing, "U" shaped
marble chips
Hydrochloric Acid, 1M,10%

Procedure

Insert each thermometer through a holed stopper.
Insert glass tubing into the remaining stopper.
Add about 30gms marble chips to one flask.
Add 100mls of acid.
Fit the stopper with the glass tube.
Deliver the gas produced into the base of a second flask.
When the reaction ceases, stopper the collection flask.

Place two flasks into sunlight, one containing air and the other containing carbon dioxide from the reaction.
Record the temperature in each flask every thirty seconds for five minutes. Graph the results.



Result: The flask containing carbon dioxide heated faster than the flask containing air.

Conclusion: Carbon Dioxide absorbs more heat from sunlight than does air.

Risk Level: Moderate Hazard: 1M Hydrochloric acid is mildly corrosive. Skin contact should be avoided and treated with thorough washing.

STUDENT:________________

80 # Guitar Science

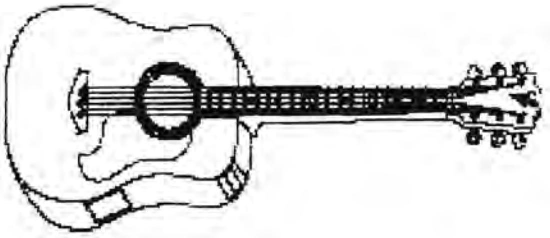
Aim: To investigate the relationship between wavelength and musical notes.

Equipment

One guitar
Tuning Forks:
C512, C256

Procedure

Using string tension, adjust one string to C256 using the tuning fork as a comparison.
Find the fret which now produces C512.
Measure the length of the string.
Measure the length to the C512 fret.
Demonstrate resonance by touching the C256 fork to the guitar body. Closely examine the string for vibration.



Results: ____

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Conclusion: ____

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80

Guitar Science

Topics: Waves

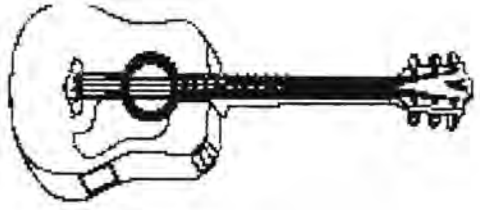
Aim: To investigate the relationship between wavelength and musical notes.

Equipment

One guitar
Tuning Forks:
C512, C256

Procedure

Using string tension, adjust one string to C256 using the tuning fork as a comparison.
Find the fret which now produces C512.
Measure the length of the string.
Measure the length to the C512 fret.
Demonstrate resonance by touching the C256 fork to the guitar body. Closely examine the string for vibration.



Result: Tightening the string increases pitch (frequency). The C512 fret is exactly half way up the string. The C256 fork causes the string to resonate.

Conclusion: High C is a note with exactly twice the frequency of Middle C. Halving the wavelength causes a doubling of the frequency. Increasing string tension increases the speed of the standing wave in the string causing it to vibrate at a higher frequency.

Risk Level: Low Hazard

STUDENT:________________

81 Halogen Ions

Aim: To investigate the reactions of some halogen ions.

Equipment

Test tubes, 8
Test tube rack
Potassium Bromide, 0.5M,5% (Dropper)
Potassium Chloride, 0.5M,4%(Dropper)
Potassium Iodide, 0.5M, 8.5% (Dropper)
Chlorine Water,(Dropper)
Bromine Water,(Dropper)
Iodine Water, (Dropper)
Potassium Ferricyanide(III) 0.5M, 21% (Dropper)
Iron (II) Sulfate, 0.5M, 11%
Iron (III) Sulfate,0.5M, 26%

Procedure

Tube 1: Add 1ml Iron (II) sulfate.
Tube 2: Add 1ml Iron (III) sulfate.
Tube 3: Add 1ml Iron (II) sulfate and 10 drops chlorine.
Tube 4: Add 1ml Iron (III) sulfate and 10 drops chloride.
Tube 5: Add 1ml Iron (II) sulfate and 10 drops bromine.
Tube 6: Add 1ml Iron (III) sulfate and 10 drops bromide.
Tube 7: Add 1ml Iron (II) sulfate and 10 drops iodine.
Tube 8: Add 1ml Iron (III) sulfate and 10 drops iodide.
Add five drops of potassium ferricyanide to each of the tubes.

Pour all wastes into the container provided in the fume hood.

Test Substance	Iron II	Iron III
Chlorine		
Chloride		
Bromine		
Bromide		
Iodine		
Iodide		

Results: ____

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Conclusion: ____

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81

Halogen Ions

Topics: Ions Elements

Aim: To investigate the reactions of some halogen ions.

Equipment

Test tubes, 8
Test tube rack
Potassium Bromide, 0.5M,5% (Dropper)
Potassium Chloride, 0.5M,4%(Dropper)
Potassium Iodide, 0.5M, 8.5% (Dropper)
Chlorine Water,(Dropper)
Bromine Water,(Dropper)
Iodine Water, (Dropper)
Potassium Ferricyanide(III) 0.5M, 21% (Dropper)
Iron (II) Sulfate, 0.5M, 11%
Iron (III) Sulfate,0.5M, 26%

Procedure

Tube 1: Add 1ml Iron (II) sulfate.
Tube 2: Add 1ml Iron (III) sulfate.
Tube 3: Add 1ml Iron (II) sulfate and 10 drops chlorine.
Tube 4: Add 1ml Iron (III) sulfate and 10 drops chloride.
Tube 5: Add 1ml Iron (II) sulfate and 10 drops bromine.
Tube 6: Add 1ml Iron (III) sulfate and 10 drops bromide.
Tube 7: Add 1ml Iron (II) sulfate and 10 drops iodine.
Tube 8: Add 1ml Iron (III) sulfate and 10 drops iodide.
Add five drops of potassium ferricyanide to each of the tubes.

Pour all wastes into the container provided in the fume hood.

Result: Ferricyanide reacts with iron (II) to give a blue colour. Chlorine and bromine coverted iron(II) to iron (III).Iodide converted iron(III) to iron(II).

Conclusion: If the halogen is sufficiently electronegative it will strip an electron from Iron Iron (II) to make Iron (III). Conversely if the halogen ion is less electronegative than Iron (III) it will loose an electron converting the Iron(III) into iron (II). Hence the experiment ranks the halogens against Iron(III).

Risk Level: Moderate Risk: Potassium ferricyanide is of low toxicity however the Halogen solutions are toxic and may give off harmful vapours. The room should be well ventilated and all wastes disposed in the fume hood sink.

STUDENT:________________

82 Harmonic Bunsen

Aim: To demonstrate harmonic resonance in open pipes.

Equipment

Cardboard Tube, min 1m long and 10cm diameter
Mekker Burner

Procedure

Light the Mekker burner.
Slowly lower the tube vertically over the burner.
Draw the apparatus in the space below.

Results: ____

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Conclusion: ____

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82

Harmonic Bunsen

Topics: Waves

Aim: To demonstrate harmonic resonance in open pipes.

Equipment

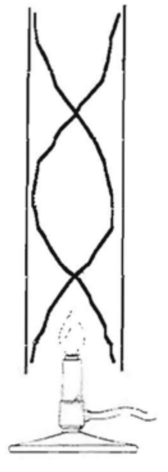
Cardboard Tube, min 1m long and 10cm diameter

Mekker Burner

Procedure

Light the Mekker burner.

Slowly lower the tube vertically over the burner.



Result: At a particular position a loud horn call resonates from the tube.

Conclusion: At a particular tube length relative to the burner, vibrations from the gas/air combustion form a standing wave in the tube. The resonating standing wave produces a loud sound.

Risk Level: Low Hazard

STUDENT: ____________________

83 Heat Absorption

Aim: To compare rate of absorption of infra red heat on dark and shiny surfaces.

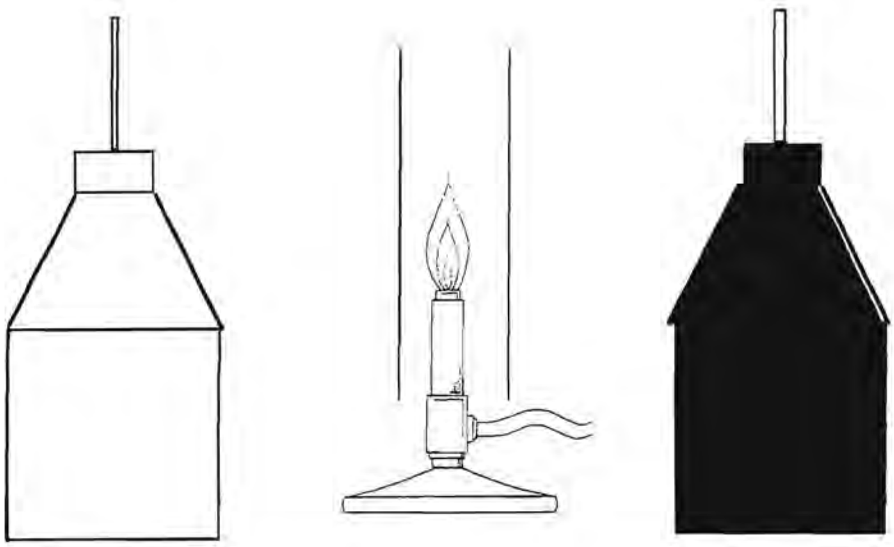
Equipment

Copper Flasks , two, fitted with corks pierced by a thermometer.
Bunsen
Retort stand, Clamps, two wire gauze, 2

Blacken one flask using the yellow flame of a Bunsen. Burnish the other flask by polishing or immersing overnight in an aluminium pot containing water and some sodium hydrogen carbonate

Procedure

Bend two wire gauze mats into shallow curves.
Use the retort stand to support the mats so they stand either side of a Bunsen with the inner curve near the flame.
Record the temperature in the copper flasks .
Place the flasks 10cm either side of the Bunsen heating the gauze mats.
Measure the temperature again after 5 minutes.



Results: ____

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Conclusion: ____

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83

Heat Absorption

Topics: Heat Light

Aim: To compare rate of absorption of infra red heat on dark and shiny surfaces.

Equipment

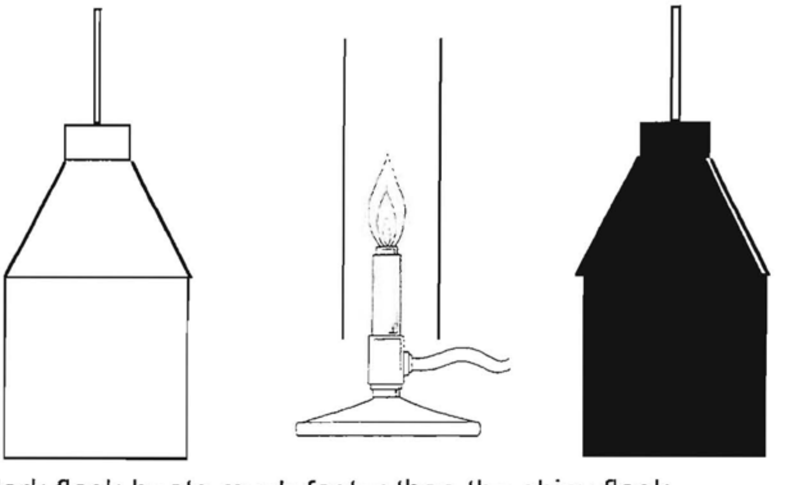
Copper Flasks , two, fitted with corks pierced by a thermometer.
Bunsen
Retort stand, Clamps, two wire gauze, 2

Blacken one flask using the yellow flame of a Bunsen. Burnish the other flask by polishing or immersing overnight in an aluminium pot containing water and some sodium hydrogen carbonate

Procedure

Bend two wire gauze mats into shallow curves.
Use the retort stand to support the mats so they stand either side of a Bunsen with the inner curve near the flame.
Record the temperature in the copper flasks .
Place the flasks 10cm either side of the Bunsen heating the gauze mats.
Measure the temperature again after 5 minutes.

Note: since it is invariably cloudy when you schedule this experiment the glowing gauze mats are a good back up. Otherwise if you are fortunate enough to have a sunny day use the sun as a heat source.



Result: The dark flask heats much faster than the shiny flask.

Conclusion: Dark objects absorb (and radiate) heat much faster than shiny or light coloured objects (as these reflect more of the infra red rays).

Risk Level: Low

STUDENT: ____________________

84 # Heat/Temp 1

Aim: To determine how the Boiling Point of water is affected by dissolved substances.

Equipment

Beaker, 250ml
Tripod
Bunsen
Retort Stand, clamp
Thermometer, 0 - 110
Sodium chloride
Sugar

Procedure

Dissolve 30g of sodium chloride in 100mls of water in the beaker.
Place the beaker on the tripod.
Adjust the retort stand to support the thermometer in the middle of the solution.
Heat with the bunsen until the solution boils and record the temperature.
Discard the solution.
Repeat the experiment with 30g of sugar.
Draw the apparatus in the space below.

Results: ____________________

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Conclusion: ____________________

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84

Heat/Temp 1

Topics: Heat Matter

Aim: To determine how the Boiling Point of water is affected by dissolved substances.

Equipment

Beaker, 250ml
Tripod
Bunsen
Retort Stand, clamp
Thermometer, 0 - 110
Sodium chloride
Sugar

Procedure

Dissolve 30g of sodium chloride in 100mls of water in the beaker.
Place the beaker on the tripod.
Adjust the retort stand to support the thermometer in the middle of the solution.
Heat with the Bunsen until the solution boils and record the temperature.
Discard the solution.
Repeat the experiment with 30g of sugar.

Result: The water boils at a temperature above 100 degrees. Slightly lower for the sugar than the salt.

Conclusion: Dissolved solutes raise the boiling point (and lower the freezing point) of solvents by making vaporisation more difficult (entropic effect). The effect of the sugar is less because the same mass of sugar has fewer molecules

Risk Level: Mild Hazard: Beware of Bumping in superheated solutions. Wear safety glasses.

STUDENT:________________

85 Heat/Temp 2

Aim: To determine if two substances heated equally reach the temperature.

Equipment

Beaker, 250ml
Tripod,
Bunsen
Test Tubes, 2
Thermometers, 2, 0 -100
Olive Oil
Test tube stand
Measuring Cylinder, 10ml
Balance. 0.1g sensitivity

Procedure

Add 5mls of cold water to one test tube.
Add 5mls of Olive oil to the other test tube.
Boil 150mls of water in the beaker.
Place both test tubes in the beaker for 30 seconds.
Place a thermometer in each test tube.
Record the temperatures.
Adjust the test tubes to equal weights of oil and water.
When both tubes have returned to room temperature, repeat the heating test.

Temp	Water	Oil
Equal Volume		
Start		
Finish		
Equal Weight		
Start		
Finish		

Results: ____

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Conclusion: ____

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85

Heat/Temp 2

Topics: Heat Atoms /Molecules

Aim: To determine if two substances heated equally reach the temperature.

Equipment

Beaker, 250ml
Tripod,
Bunsen
Test Tubes, 2
Thermometers, 2, 0 -100
Olive Oil
Test tube stand
Measuring Cylinder, 10ml
Balance. 0.1g sensitivity

Procedure

Add 5mls of cold water to one test tube.
Add 5mls of Olive oil to the other test tube.
Boil 150mls of water in the beaker.
Place both test tubes in the beaker for 30 seconds.
Place a thermometer in each test tube.
Record the temperatures.
Adjust the test tubes to equal weights of oil and water.
When both tubes have returned to room temperature, repeat the heating test.

Result: The temperature of the olive oil increased faster than the water but this difference was reduced when equal masses were compared rather than equal volumes.

Conclusion: Both substances absorbed equal amounts of heat energy, however their molecules did not acquire the same kinetic energy (temperature). Heat and Temperature are different. In this case the intermolecular forces are much stronger in water than in olive oil and since the oil is less dense this effect is more pronounced when comparing volumes.

Risk Level: Low Hazard

STUDENT:________________

86 Hot air Balloon

Aim: To demonstrate the principle of lighter than air flight.

Equipment

Large size, light gauge,
Kitchen tidy bags
Cotton Wool
Methanol
Nichrome Wire

Procedure

Cut 30cm length of nichrome wire.
Thread a small wad of cotton wool onto the wire.
Hook the wire across the open mouth of a kitchen tidy bag
Invert the bag.
Soak the cotton wool with methylated spirits.
While an assistant holds the mouth of the bag open, light the cotton wool.

Wait until the methylated spirits is fully consumed and the cotton wool almost completely burnt, then release the bag
Hints: Do not use too much wire, weight is critical
Perform the experiment on the school oval when only a light breeze is blowing.

Results: ____

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Conclusion: ____

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86

Hot air Balloon

Topics: Density/Pressure Flight

Aim: To demonstrate the principle of lighter than air flight.

Equipment

Large size, light gauge,
Kitchen tidy bags
Cotton Wool
Methanol
Nichrome Wire

Procedure

Cut 30cm length of nichrome wire.
Thread a small wad of cotton wool onto the wire.
Hook the wire across the open mouth of a kitchen tidy bag
Invert the bag.
Soak the cotton wool with methylated spirits.
While an assistant holds the mouth of the bag open, light the cotton wool.

Wait until the methylated spirits is fully consumed and the cotton wool almost completely burnt, then release the bag
Hints: Do not use too much wire, weight is critical
Perform the experiment on the school oval when only a light breeze is blowing.

Result: The bag rose to height of about 20 metres and remained aloft for about 30 seconds.

Conclusion: The flame caused air in the bag to expand and become less dense. The surrounding cooler, denser air , pushed the bag upwards (it was not pulled)

Risk Level: Mildly Hazardous: Ensure that fire risk in the area is acceptable. Be sure that the mouth of the bag is held wide so that flames do not reach the plastic.

STUDENT: ________________

87 Human Power

Aim: To measure the power output of leg muscles.

Equipment

Tape measure
Stop watch
Bathroom scales

Procedure

Measure the height of a flight of stairs.
Students time how long it takes them to race from the bottom to the top.
Power = work / time
Work = Joules expended = PE gained = mgh
Power = Mass of student X 9.8 X Height stairs / time taken
= ________ X 9.8 X ______ / ______

= _______ Watts.

Results: ____

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Conclusion: ____

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87

Human Power

Topics: Energy Energy in Life Machines

Aim: To measure the power output of leg muscles.

Equipment

Tape measure
Stop watch
Bathroom scales

Procedure

Measure the height of a flight of stairs.
Students time how long it takes them to race from the bottom to the top.
Power = work / time
Work = Joules expended = PE gained = mgh
Power = Mass of student X 9.8 X Height stairs / time taken

Answer is in Watts.

Result:

Conclusion: This experiment is a very useful comparison to other machines eg 1 Horsepower = 750 W, Electric drill 600W, Toaster 2200W.

Risk Level: Mild Hazard : Choose a straight flight of stairs to reduce falls.

STUDENT:__________________

88

Hydrogen

Aim: To produce and observe a property of hydrogen gas; to compare the reactivity of various metals with acid.

Equipment

5 test tubes
Hydrochloric Acid 1M, 10%
Wooden Tapers
Magnesium Ribbon
Zinc
Iron nail

Procedure

Pour about 4cm of acid into each test tube.
Add a length of magnesium ribbon to the first tube .
Collect the gas produced by holding a thumb over the tube.
Light a taper.
Bring the flame to the tube mouth then release the gas.
Add a sample of the other metals to the remaining tubes.
Compare the vigour of the reaction.
Draw the experiment in the space below.

Results: ____

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Conclusion: ______________________________________

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88

Hydrogen

Topics: Chemical reactions Elements Acids and Bases

Aim: To produce and observe a property of hydrogen gas; to compare the reactivity of various metals with acid.

Equipment

5 test tubes
Hydrochloric Acid 1M, 10%
Wooden Tapers
Magnesium Ribbon
Zinc
Iron nail

Procedure

Pour about 4cm of acid into each test tube.
Add a length of magnesium ribbon to the first tube .
Collect the gas produced by holding a thumb over the tube.
Light a taper.
Bring the flame to the tube mouth then release the gas.
Add a sample of the other metals to the remaining tubes.
Compare the vigour of the reaction.

Result: Hydrogen gas is colourless and explodes with a pop when ignited with air; Hydrogen is produced in the reaction of metals with acid; Magnesium is most reactive , followed by zinc, then iron , then copper.

Conclusion: Acid + Metal > Salt + Hydrogen

Risk Level: Mild Hazard: Hydrogen is explosive and should only be collected by students in small quantities ie test tubes. Hydrochloric acid 1M is corrosive and skin contact should be treated by vigorous washing with water.

STUDENT:________________

89 Hydrogen Balloons

Aim: To demonstrate that hydrogen gas has a low density compared to air.

Equipment

Aluminium Foil
500ml, Side Arm Conical flask and stopper
Sodium Hydroxide
Plastic Trough
Plastic Tubing, 2m
Round Party Balloon
Scissors
Cotton Thread
Rubber Gloves
Rubber Band
Protective Glasses

Procedure

Draw the apparatus used by the teacher.
Explain the result.

Results: ________________________________

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Conclusion: ________________________________

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89

Hydrogen Balloons

Topics: Density/ Pressure Elements

Aim: To demonstrate that hydrogen gas has a low density compared to air.

Equipment

Aluminium Foil
500ml, Side Arm Conical flask and stopper
Sodium Hydroxide
Plastic Trough
Plastic Tubing, 2m
Round Party Balloon
Scissors
Cotton Thread
Rubber Gloves
Rubber Band
Protective Glasses

Procedure

Roll Aluminium foil into pellets 5cm long, 1cm Dia., 10 total.
Add water to the flask to a depth of about 3cm.
Add 20g of sodium hydroxide to the water and dissolve.
Fill plastic tray with water.
Fix the balloon over the end of the tubing with a rubber band.
Coil the tubing in the water trough and connect the remaining end to the side arm flask.

Add five aluminium pellets to the flask.
When the reaction is vigorous, stopper the flask .
When the reaction slows, pinch the balloon mouth, then add the remaining Aluminium pelletsWhen the reaction ceases, hold the balloon vertical to allow any condensation to drain then tie off the mouth with several turns of cotton thread.
Cut the balloon free of the tube.
Hints: Weight is critical. The reaction is exothermic and vigorous. The two step addition of aluminium helps control the reaction and limit condensation. Cutting the balloon free removes the heavy rolled mouth.

Result: The balloon gracefully rises to the ceiling.

Conclusion: Hydrogen gas is less dense than air.

Risk Level: HAZARDOUS: TEACHER DEMO ONLY. Sodium hydroxide is extremely caustic. Skin contact must be treated with immediate a prolonged washing. hydrogen gas is explosive and the balloon may contain caustic droplets. DO NOT IGNITE THE BALLOON.

STUDENT:________________

90 Hydrophilic/ phobic

Aim: To observe the interaction of water with hydrophilic and hydrophobic surfaces.

Equipment

Microscope slides, two
Dropper
Capillary tubes, 20cm
Glass Tubing 10mm diam, 20cm length, two
Beaker, 100ml
Vacuum grease
Heat vacuum grease in a test tube until it liquefies. Dip one of the 10mm glass tubes into the liquid. Withdraw and clean the outer surface with a rag.

Procedure

Smear vacuum grease on a glass slide.
Place droplets of water on the greased slide and a clean slide.
Draw the droplets as they appear from the side.
Put some water in the beaker.
Stand the two 10mm glass tubes in the water.
Draw the shape of water surface inside the tube (meniscus).
Add a capillary tube to the beaker.
Draw the water level in the capillary tube comared to the water level in the beaker.

Results: ____

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Conclusion: ____

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90

Hydrophilic/ phobic

Topics: Water How atoms Join

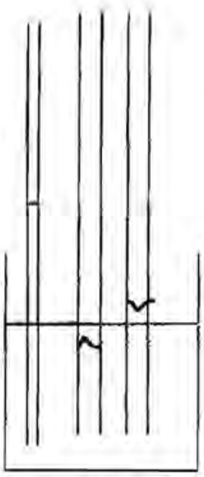
Aim: To observe the interaction of water with hydrophilic and hydrophobic surfaces.

Equipment

Microscope slides, two
Dropper
Capillary tubes, 20cm
Glass Tubing 10mm diam, 20cm length, two
Beaker, 100ml
Vacuum grease
Heat vacuum grease in a test tube until it liquefies. Dip one of the 10mm glass tubes into the liquid. Withdraw and clean the outer surface with a rag.

Procedure

Smear vacuum grease on a glass slide.
Place droplets of water on the greased slide and a clean slide.
Draw the droplets as they appear from the side.
Put some water in the beaker.
Stand the two 10mm glass tubes in the water.
Draw the shape of water surface inside the tube (meniscus).
Add a capillary tube to the beaker.



Result: The droplet on the clean slide is flat while the droplet on grease is high and rounded. The meniscus in the glass tube is higher and bellied down. The meniscus in the greased tube is low the water and bellied up.

Conclusion: Water is attracted to glass ie glass is hydrophilic. This explains why water climbs the glass/ water boundary and why it climbs upward in narrow capillary tubes. Water is repelled by grease ie. grease is hydrophobic. This explains why the meniscus in the greased tube is low the and inverted.

Risk Level: Low Hazard

STUDENT:________________

91 Ice Cream

Aim: To use the latent heat of salt to produce sub-zero temperatures.

Equipment

Mixing bowl, large
Plastic ice cream tub
Mixing spoon
Cream
Sugar
Vanilla essence
Crushed ice
Salt
Kitchen cup

Procedure

In the ice cream tub mix:
1/2 teaspoon vanilla essence
2 teaspoons sugar
1/3 cup cream
In the mixing bowl mix 3 cups of ice and 1 cup of salt.
Nestle the ice cream tub into the ice/salt mix and slowly stir the ice cream mix for 10 minutes.

Results: ____

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Conclusion: ____

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91 Ice Cream

Topics: Changes of State Heat

Aim: To use the latent heat of salt to produce sub-zero temperatures.

Equipment	**Procedure**
Mixing bowl, large	In the ice cream tub mix:
Plastic ice cream tub	1/2 teaspoon vanilla essence
Mixing spoon	2 teaspoons sugar
Cream	1/3 cup cream
Sugar	In the mixing bowl mix 3 cups of ice and 1 cup of salt.
Vanilla essence	Nestle the ice cream tub into the ice/salt mix and slowly stir
Crushed ice	the ice cream mix for 10 minutes.
Salt	
Kitchen cup	

Result: The ice cream slowly freezes in the ice/salt mix.

Conclusion: Ice cream freezes at a temperature (- 4 degrees) lower than water. When salt is added to water, latent heat is absorbed as the salt dissolves into the aqueous state and so the temperature of the ice / salt mixture falls below -4 degrees. Likewise the salt is forcing ice to melt at a lower temperature.

Risk Level: Low Hazard: Only cooking grade utensils and ingredients should be used and all surfaces should be very clean.

STUDENT:________________

Impulse

Aim: To measure collision times for various falling objects and produce force versus time graphs for the collisions.

Equipment

Tennis Ball
Cricket Ball
Base Ball
Alfoil
Event Timer (Electronic)
2 Connecting Wires (1m)
Metre Rule
Balance (1g)
Alligator clips

Procedure

Wrap each ball in alfoil.
Use the alligator clips to connect the event timer to an aluminium foil sheet placed on the ground and one of the balls.
Let each ball drop from 1 metre.
A side observer estimates the rebound height against the ruler.
Record the collision time and calculate the velocity for the impact and rebound.

The collision time gives the graph base while the velocity figures give the change in momentum of the impact and rebound ie the area under the graph for impact and rebound $mgh = 1/2\ mv^2$, v = square root $19.8h$

Ball	Mass	Velocity	Height	Time

Ball	Velocity 2	Mom1	Mom2	Max Force

Results: ____

____

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Conclusion: ____

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92

Impulse

Topics: Momentum

Aim: To measure collision times for various falling objects and produce force versus time graphs for the collisions.

Equipment

Tennis Ball
Cricket Ball
Base Ball
Alfoil
Event Timer (Electronic)
2 Connecting Wires (1m)
Metre Rule
Balance (1g)
Alligator clips

Procedure

Wrap each ball in alfoil.
Use the alligator clips to connect the event timer to an aluminium foil sheet placed on the ground and one of the balls.
Let each ball drop from 1 metre.
A side observer estimates the rebound height against the ruler.
Record the collision time and calculate the velocity for the impact and rebound.

The collision time gives the graph base while the velocity figures give the change in momentum of the impact and rebound ie the area under the graph for impact and rebound
$mgh = 1/2\ mv^2$, v = square root $19.8h$

Result: All the collisions are inelastic, the tennis ball yielding the longest collision time.

Conclusion: The cricket ball being most massive and least elastic, yields a very high peaked Force / time graph (highest average force).

Risk Level: Low Hazard.

STUDENT:________________

93 Instant Hydrometer

Aim: To demonstrate how Pascals Principle is applied in hydrometers.

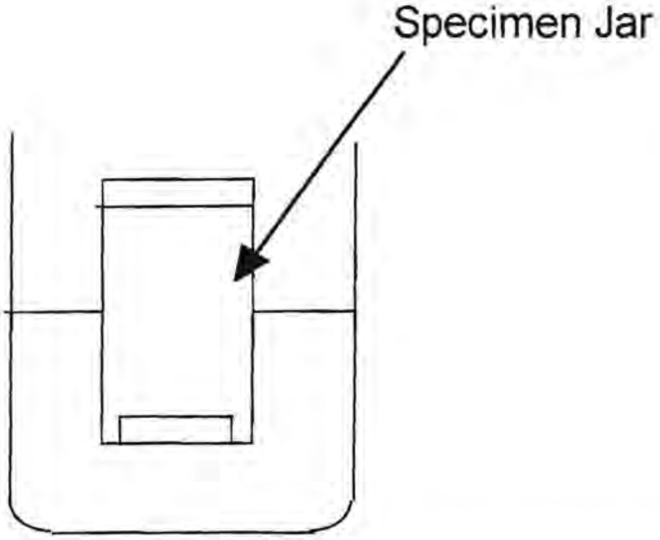
Equipment

Plastic specimen tube, 140ml
Masses, 2 x 50g, 25g
Measuring cylinder, 100ml
Methylated spirits
Sodium Chloride
Balance, 0.1g sensitivity
Beaker 400ml
Marking pen

Procedure

Fill the specimen tube with water and pour it into the measuring cylinder to determine the volume.
Add the 75g in masses to the specimen tube and weigh on a balance.
Determine the density, (mass /volume).
Float the specimen tube in a beaker.
Mark the water level on the side of the specimen tube.
Mark this line as 1.00.
Measure the length of the tube, your line should be about half way.

Mark another line half way to the lid as 0.70.
Mark another line half way to the base as 1.9.
Mark lines half way between these as 0.8 and 1.4.
Add 50g of salt to the water in the beaker and dissolve.
Use your hydrometer to estimate the new density.
Use your Hydrometer to find the density of methylated spirits.



Results: ____

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Conclusion: ____

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93

Instant Hydrometer

Topics: Density/ Pressure

Aim: To demonstrate how Pascals Principle is applied in hydrometers.

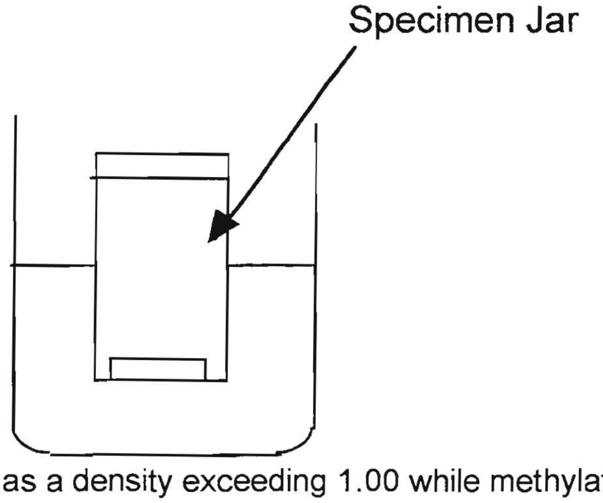
Equipment

Plastic specimen tube, 140ml
Masses, 2 x 50g, 25g
Measuring cylinder, 100ml
Methylated spirits
Sodium Chloride
Balance, 0.1g sensitivity
Beaker 400ml
Marking pen

Procedure

Fill the specimen tube with water and pour it into the measuring cylinder to determine the volume.
Add the 75g in masses to the specimen tube and weigh on a balance.
Determine the density, (mass /volume).
Float the specimen tube in a beaker.
Mark the water level on the side of the specimen tube.
Mark this line as 1.00.
Measure the length of the tube, your line should be about half way.

Mark another line half way to the lid as 0.70.
Mark another line half way to the base as 1.9.
Mark lines half way between these as 0.8 and 1.4.
Add 50g of salt to the water in the beaker and dissolve.
Use your hydrometer to estimate the new density.
Use your Hydrometer to find the density of methylated spirits.



Result: Salt water has a density exceeding 1.00 while methylated spirits has a density around 0.78.

Conclusion: The density at different float levels is found by dividing the mass by the volume of the tube which would be submerged. That is an object always floats so that it displaces a volume of liquid which would equal the objects mass. (Question: What would happen to a submarine entering a river? or if it travelled from the north pole to the warm equatorial water?)

Risk Level: Low Hazard: Methylated spirits is flammable and must be isolated from flames.

STUDENT:________________

94 Internal Reflection

Aim: To observe total internal reflection.

Equipment
Fish Tank
Sugar, 500g
Laser (or Hudson ray box)

Procedure
Draw the apparatus.
Explain the result.

Results: ______________________________

____

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Conclusion: ______________________________

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94

Internal Reflection

Topics: Light Wave Props Light

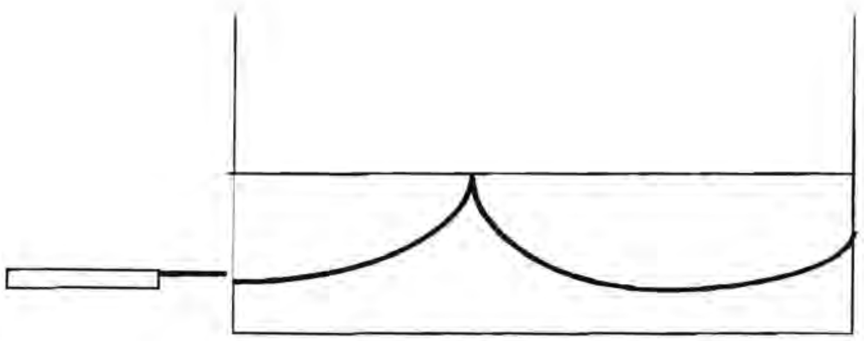
Aim: To observe total internal reflection.

Equipment

Fish Tank
Sugar, 500g
Laser (or Hudson ray box)

Procedure

Fill a small fish tank with water.
Dump 0.5 kg of sugar in the tank, do not stir.
Leave undisturbed overnight.
Shine a light beam along the liquid density boundary parallel to the fish tank base.



Result: The beam bends to the top, reflects back and then arcs back to bottom and so on.

Conclusion: The sugar creates a density gradient which causes the beam to refract in an arc while the liquid/air interface causes total internal reflection.

Risk Level: Low Hazard

STUDENT:________________

95 Internal Resistance

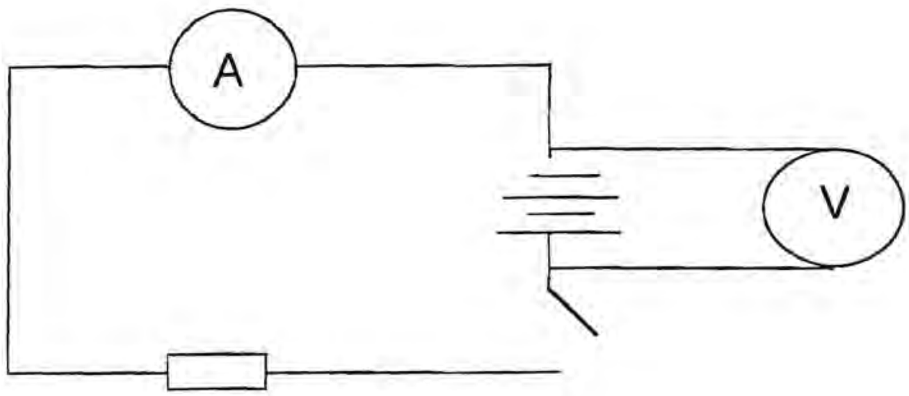
Aim: To determine the internal resistance of a battery.

Equipment

Battery, 9V
Battery clip leads
Voltmeter, 0 -20v
Ammeter, 0 -1A
Resistor, 10 Ohm
Connecting leads, 6

Procedure

Connect the Voltmeter across the battery leads.
Record the open circuit Voltage (EMF).
Connect the Ammeter and Resistor in a series circuit with the battery.
Record the Voltage and Amperage.
The closed circuit voltage is less than the original open circuit voltage since there is now a voltage loss within the battery due to internal resistance.
$V = IR$, Internal Resistance = Change in Voltage / Current



Results: ____

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Conclusion: ____

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95

Internal Resistance

Topics: Electricity

Aim: To determine the internal resistance of a battery.

Equipment

Battery, 9V
Battery clip leads
Voltmeter, 0 -20v
Ammeter, 0 -1A
Resistor, 10 Ohm
Connecting leads, 6

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Record the open circuit Voltage (EMF).
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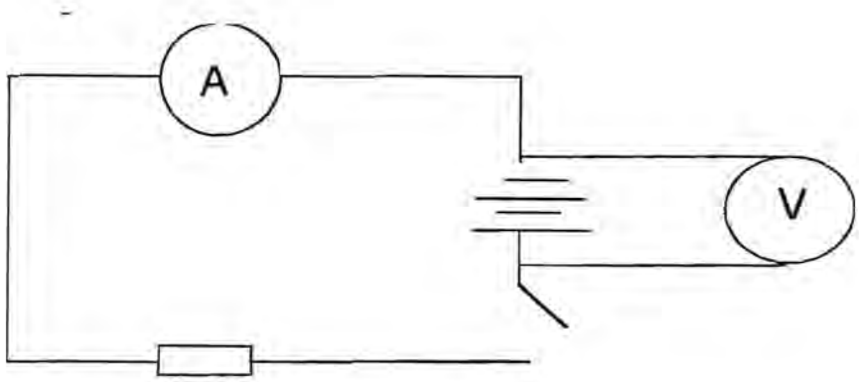

Result:

Conclusion: Internal resistance in batteries is a result of limitations on the rate of ion exchange between the electrodes and electrolyte. Surface area is a limiting factor so batteries which need to deliver large amperages have large, flat electrodes. Internal resistance will increase as larger currents are demanded from the battery.

Risk Level: Low Hazard

STUDENT:________________

Invertebrates 2

Aim: To closely observe various small invertebrates.

Equipment

Dissecting Microscope
Compound Microscope
Petri dishes, small
Microscope Slides with concave depression.

Procedure

Collect various small insects from soil into petri dishes.
Collect samples of mosquito larvae and fish pond sediment
Examine the insects using the Dissecting Microscope.
Examine the larvae and fish pond sediment using concave slides and a compound microscope at low power.
Try to draw some of the organisms you see.
(rotifers, paramecia and nematodes should be easily seen using the 10X objective)

Results: ______________________________

____

____

Conclusion: ______________________________

____

____

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Invertebrates 2

Topics: Invertebrates Biology

Aim: To closely observe various small invertebrates.

Equipment

Dissecting Microscope
Compound Microscope
Petri dishes, small
Microscope Slides with concave depression.

Procedure

Collect various small insects from soil into petri dishes.
Collect samples of mosquito larvae and fish pond sediment
Examine the insects using the Dissecting Microscope.
Examine the larvae and fish pond sediment using concave slides and a compound microscope at low power.
Try to draw some of the organisms you see.
(rotifers, paramecia and nematodes should be easily seen using the 10X objective)

Result: Various cries of "Yuk" and "Wow"

Conclusion:

Risk Level: Low Hazard

STUDENT:________________

97 Invisible beams

Aim: To demonstrate invisible radiation with a variation of Bequerels experiment.

Equipment

Maltese Cross vacuum tube
Power Supply, DC 6V
Induction Coil
Photographic paper, 1 (unexposed in wrapper)
Connecting leads, 4

Procedure

Connect the Vacuum tube terminals to the high voltage terminals of the induction coil.
Connect the power supply (6V, DC) to the input terminals of the induction coil.
Turn off the lights and draw the blinds.
Turn on the power.
Hold the photographic paper in its plastic wrapper close to the Maltese cross end of the vacuum tube for 2 minutes.
Have the paper developed by the photography teacher or by injecting Hypo solution into the bag.

Draw the pattern developed on the paper.

Hint: if no yellow glow is observed, try reversing the the electrodes on the vacuum tube.

Results: ____

____

____

Conclusion: ____

____

____

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97

Invisible beams

Topics: Atoms & Molecules   Nuclear Physics

Aim: To demonstrate invisible radiation with a variation of Bequerels experiment.

Equipment

Maltese Cross vacuum tube
Power Supply, DC 6V
Induction Coil
Photographic paper, 1 (unexposed in wrapper)
Connecting leads, 4

Procedure

Connect the Vacuum tube terminals to the high voltage terminals of the induction coil.
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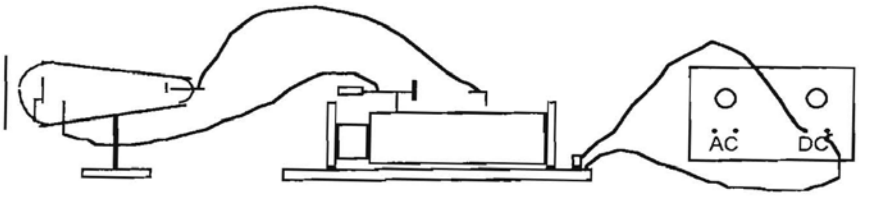

Result: A faint yellow glow could be seen on the glass of the vacuum tube outlining the cross. The photographic paper was found to have a black outline of the cross.

Conclusion: The induction coil produces a beam of electrons in the vacuum tube with the Maltese cross as a target. Many of the electrons over shoot the target, striking the glass and producing a fluorescent glow. Some electrons proceed through the glass, air and plastic wrapper to expose the photographic paper. Note: this experiment can also be used with foil barriers and other radioactive sources.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY
The induction coil produces very high voltages.

STUDENT:________________

98

Invisible Ink

Aim: To demonstrate a physical use of a chemical reaction.

Equipment

Paper
Feather Quills
Safety Razor
Lemon
Bunsen
watch glass
Hair drier (optional)

Procedure

Squeeze a half a lemon collecting the juice into a watch glass.
Cut the end of a feather quill diagonally to expose the hollow core and create a point.
Dip the quill into lemon juice and write a message on a sheet of paper.
Write your name in pencil at the top of the paper.
Allow the sheet to dry over night or quickly in a warm air stream from a hair drier.
To reveal the message hold 10cm above a bunsen.

Results: ____

____

____

Conclusion: ____

____

____

TEACHER COPY

98

Invisible Ink

Topics: Making Chemicals   Organic Chemistry

Aim: To demonstrate a physical use of a chemical reaction.

Equipment

Paper
Feather Quills
Safety Razor
Lemon
Bunsen
watch glass
Hair drier (optional)

Procedure

Squeeze a half a lemon collecting the juice into a watch glass.
Cut the end of a feather quill diagonally to expose the hollow core and create a point.
Dip the quill into lemon juice and write a message on a sheet of paper.
Write your name in pencil at the top of the paper.
Allow the sheet to dry over night or quickly in a warm air stream from a hair drier.
To reveal the message hold 10cm above a bunsen.

Result: The invisible writing is revealed as brown staining.

Conclusion: The organic compounds in lemon juice include some which readily oxidise when heated.

Risk Level: Low Hazard

STUDENT: ____________________

99

Iodate Clock

Aim: To investigate the effect of reactant concentrations on reaction rate.

Equipment

Test tubes, 5
Test Tube Rack
Measuring Cylinder, 10ml
Potassium Iodate, 0.43%
Stop watch
Solution B:(Mix 8g starch in 50mls water then add slowly to 900ml of boiling water. Allow to cool then add 0.4g sodium Metabisulfate and 10ml Sulfuric acid 1M, 5.5%. Make up to 2 litres with cold water.)
Note: Solution B must be made up within 6 hours of the experiment.

Procedure

Add 8ml of Iodate to 2mls of water in a test tube.
Record the time for a blue colour to develop in each of the following mixtures.
Add 8ml of Iodate to 2mls of solution B in a test tube.
Add 6ml of Iodate to 4mls of solution B in a test tube.
Add 4ml of Iodate to 6mls of solution B in a test tube.
Add 2ml of Iodate to 8 mls of solution B in a test tube.

Iodate (mls)	Rn Time

Results: ____

____

____

Conclusion: ____

____

____

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99

Iodate Clock

Topics: Equilibrium Chemical Reactions Reaction Rates

Aim: To investigate the effect of reactant concentrations on reaction rate.

Equipment

Test tubes, 5
Test Tube Rack
Measuring Cylinder, 10ml
Potassium Iodate, 0.43%
Stop watch
Solution B:(Mix 8g starch in 50mls water then add slowly to 900ml of boiling water. Allow to cool then add 0.4g sodium Metabisulfate and 10ml Sulfuric acid 1M, 5.5%. Make up to 2 litres with cold water.)
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Add 6ml of Iodate to 4mls of solution B in a test tube.
Add 4ml of Iodate to 6mls of solution B in a test tube.
Add 2ml of Iodate to 8 mls of solution B in a test tube.

mls Iodine	Rn. Time

Result: The reaction is fastest when the Iodate concentration is highest.

Conclusion: The blue reaction is a complex formed between dissolved molecular Iodine and Starch. Iodate is converted to ions by the Metabisulfate and thence to molecular iodine by hydrogen ions, however Metabisulfate also converts molecular iodine back into ions. The visible reaction is delayed until the Metabisulfate is consumed, so less Metabisulfate means a shorter delay.

Risk Level: Mild Hazard

STUDENT COPY

100

Ions

Aim: To test several compounds for the presence of conducting ions in solution.

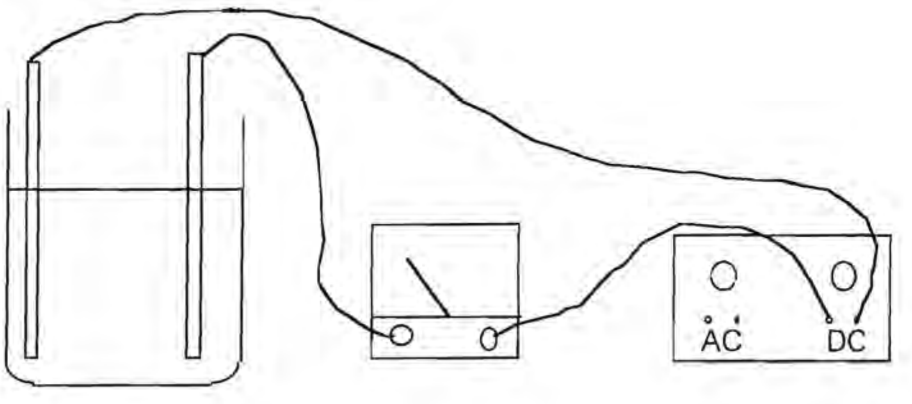
Equipment

Power supply, 0 -12 V, DC
Connecting Leads, three
beaker, 250ml
Copper Electrodes, two
Ammetre, 0 -5000milliamp
Sodium Chloride
Copper Sulfate
Copper Carbonate
Calcium Carbonate
Hydrochloric Acid, IM, 10%

Procedure

Adjust the power supply to its lowest setting, DC current.
DO NOT TURN ON THE POWER.
Connect the positive DC power terminal to the positive side of the Ammeter using a connecting lead.
Connect the negative DC power terminal to a copper electrode using a lead and an alligator clip.
Connect the negative Ammeter terminal to the second copper electrode using a lead and an alligator clip.
Place both electrodes in the beaker so they do not touch.
Add 100mls of water to the beaker.

Turn on the power briefly and record the current flow.
Add a few mls of acid to the water and record the current.
Turn off the power and replace the water.
Dissolve some copper sulfate in the water, turn on the power and record the current.
Repeat the last two steps for copper carbonate, then sodium chloride, and finally calciuim carbonate.
Water is the "control" in this experiment.



Results: ______________________________

____

____

Conclusion: ______________________________

____

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TEACHER COPY

100

Ions

Topics: How Atoms Join   Ions   Solubility

Aim: To test several compounds for the presence of conducting ions in solution.

Equipment

Power supply, 0 -12 V, DC
Connecting Leads, three
beaker, 250ml
Copper Electrodes, two
Ammetre, 0 -5000milliamp
Sodium Chloride
Copper Sulfate
Copper Carbonate
Calcium Carbonate
Hydrochloric Acid, IM, 10%

Procedure

Adjust the power supply to its lowest setting, DC current.
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Place both electrodes in the beaker so they do not touch.
Add 100mls of water to the beaker.

Turn on the power briefly and record the current flow.______
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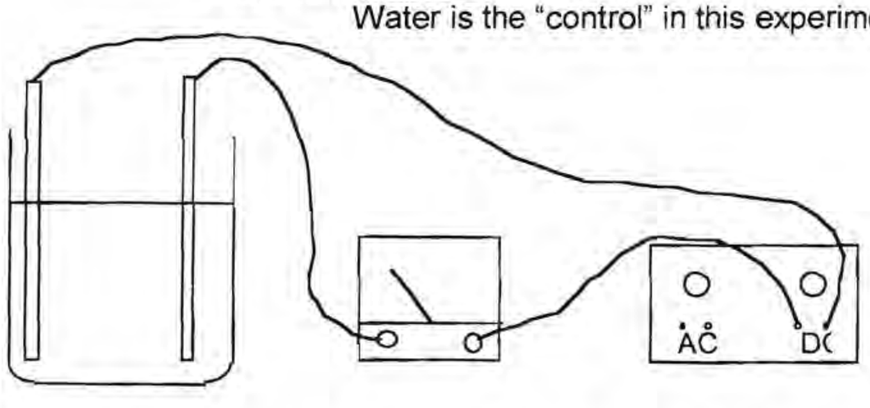
Turn off the power and replace the water.
Dissolve some copper sulfate in the water, turn on the power and record the current. _______
Repeat the last two steps for copper carbonate, ______, then sodium chloride,______, and finally calciuim carbonate,_______.

Water is the "control" in this experiment.



Result: Insoluble salts produce minimal current flow while soluble salts or acid produce good current flows.

Conclusion: Soluble salts and acids produce ions in solution which can carry electric current.

Risk Level: Mild Hazard: Copper carbonate and copper sulfate are harmful if ingested. copper sulfate may irritate the skin.

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